LAKE SUPERIOR LITHIUM PROJECT

PRELIMINARY ECONOMIC ASSESSMENT

Avalon Advanced Materials Inc.

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ABBREVIATIONS, TERMS AND DEFINITIONS

Abbreviations/Terms	Definition
$/t	Dollar per tonne
$M	Million Dollars
%	Percent
°F	Degree Fahrenheit
µm	Micron
AACE	Association for the Advancement of Cost Engineering
Al	Aluminum
Al_2O_3	Aluminum Oxide
asl	Above Sea Level
ATM	Atmospheric
barg	Bar Gauge (measurement of pressure)
BFD	Block Flow Diagram
$Ca_5(PO_4)_3F$	Apatite
CAD	Canadian Dollar
CADD	Computer Aided Design and Drafting
CaO	Calcium Oxide
Capex	Capital Expenditure
CCA	Capital Cost Allowance
CN	Canadian National
CO_2	Carbon Dioxide
CO_3^{2-}	Carbonate Ion
CSL	CSL Environmental and Geotechnical Ltd.
DCF	Discounted Cash Flow
DFO	Department of Fisheries and Oceans (Canada)
DRA	DRA Americas Inc.
DWT	Deadweight tonnage
EC&I	Electrical, Control and Instrumentation
ECA	Environmental Compliance Approval
ECCC	Environmental and Climate Change Canada
EPC	Engineering, Procurement and Construction
EPCM	Engineering, Procurement and Construction Management
EV	Electrical Vehicle
Fe_2O_3	Iron (III) oxide

Abbreviations/Terms	Definition
FEED	Front-End Engineering Design
FIFO	fly-in-fly-out
FOB	Free on Board
FWFN	Fort William First Nation
g/L	Gram per Litre
h/y	Hour per Year
HADD	Harmful Alteration, Disruption or Destruction
HAZOP	Hazard and Operability
HCl	Hydrochloric Acid
HP	High Pressure
I.D. fan	Induced Draft Fan
IAA	Impact Assessment Act
IRR	Internal Rate of Return
ITC	Investment Tax Credits
IX	Ion Exchange
K	Potassium
$KAl_2(AlSi_3O_{10})(OH)_2$	Muscovite
$KAlSi_3O_8$	K-Feldspar
kJ/kg°C	Kilojoule per Kilogram per Degree Celsius
km	Kilometre
kt	Kilotonne
kt/y	Kilotonne per year
kV	Kilovolt
kVA	Kilovolt-Ampere
kV-Ar	Kilovolt-Ampere Reactive
kW	Kilowatt
kWh/t	Kilowatt-hours per tonne
LCE	Lithium Carbonate Equivalent
LHM	Lithium Hydroxide Monohydrate
Li_2CO_3	Lithium Carbonate
Li_2O	Lithium Oxide
LiOH	Lithium Hydroxide
$LiOH.H_2O$	Lithium Hydroxide Monohydrate
LOP	Life of Project

Abbreviations/Terms	Definition
M	Moles
m	Metre
m^3/day	Cubic Metre per Day
m asl	Metres Above Sea Level
MECP	Ministry of the Environment, Conservation and Parks
MgO	Magnesium Oxide
mm	Millimetre
MnO	Manganese Oxide
MNR	Ministry of Natural Resources
Mt	Million Tonne
MTO	Material Take-off
MVA	Megavolt-Ampere
MVR	Mechanical Vapour Recompression
Na	Sodium
Na_2SO_4	Sodium Sulphate
$NaAlSi_2O_6 \cdot H_2O$	Analcime Solids
NaOH	Sodium Hydroxide
Nm^3/h	Normal Cubic Metre per Hour
NPI	Non-Process Infrastructure
NPV	Net Present Value
OGS	Ontario Geological Survey
ON	Ontario
Opex	Operating Expenditure
P_{100}	Passing 100%
PEA	Preliminary Economic Assessment
pH	Power of hydrogen (measurement of acidity)
psig	Pounds per Square Inch Gauge
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
RFQ	Request for Quotation
ROS	Required on Site
RRCA	Railway Relocation and Crossing Act
Si	Silicon
SiO_2	Silicon Dioxide

Abbreviations/Terms	Definition
Slurry	A semiliquid mixture of particles suspended in solution
SO_4^{2-}	Sulphate Ion
SoCC	Species of Conservation Concern
spp.	Several Species
t/h	Tonne per Hour
t/m^3	Tonne per Cubic Metre
t/y or t/a	Tonne per Year/annum
TC	Transport Canada
U/G	Underground
UPS	Uninterruptable Power Supplies
USD	United States Dollar
UTM	Universal Transverse Mercator
V	Volt
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
w/w%	Percent of Weight per Weight
WBS	Work Breakdown Structure
Wi	Work Index
ZLD	Zero Liquid Discharge

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1 EXECUTIVE SUMMARY

Avalon Advanced Materials Inc. (Avalon) requested DRA Americas Inc. (DRA) to prepare a Preliminary Economic Assessment (PEA) to define the viability of a lithium hydroxide (LiOH) processing facility, Lake Superior Lithium Project, within the city limits of Thunder Bay, Ontario, Canada at its recently purchased lakeside Property. The plant is to utilize the proprietary LiOH conversion process designed by Metso; a large multinational company headquartered in Finland. The study is also to consider all auxiliary support processes, buildings and utilities required. Table 1.1 summarizes the results of the study:

Table 1.1– Project Summary

Description	Units	Value
Operating life	years	30
Steady state spodumene feed rate	t/y	196,000
Spodumene feed grade	% Li_2O	6
Lithium recovery	%	89.1
Steady state LHM production rate	t/y	30,000
Development capital cost	$ Billion (1)	1.213
Spodumene price (USD$1,000/t)	$/t	1,360
Steady state operating cost	$/t product	13,029
LiOH sale price (USD$26,000/t)	$/t	35,360
Pre-tax net present value (NPV) @8% discount rate	$ Billion	5.56
Pre-tax internal rate of return (IRR)	%	55.5
Pre-tax discounted payback period	years	2.2
After tax net present value (NPV) @8% discount rate	$ Billion	4.12
After tax internal rate of return (IRR)	%	47.5
After tax discounted payback period	years	2.5

(1) All dollar amounts in this Report are stated in Canadian dollars, unless otherwise noted.

The PEA indicates a strong financial case to proceed to the next phase of the Lake Superior Lithium Project. The following conclusions can be drawn from the study:

- The development capital cost (Class 5 estimate accuracy) is anticipated to be CAD$1.213 billion.
- The steady state operating cost for the plant is anticipated to be CAD$13,029/t of lithium hydroxide monohydrate (LHM) produced (including spodumene purchase and transport costs).

- The after tax NPV (8%) and IRR for the 30-year life of project are anticipated to be CAD4.12 billion and 47.5% respectively. The financial model is most sensitive to LHM sale price and less so to Opex and capital costs.
- The industrial land purchased for the project (Project site) is suitable for adapting the existing infrastructure and building additional infrastructure. It is already well serviced by road, deep-water port, rail, power and all utilities.

2 INTRODUCTION AND BACKGROUND

Avalon Advanced Materials Inc. (Avalon) is executing on a key strategic objective of developing Ontario's first midstream lithium hydroxide (LiOH) processing facility in Thunder Bay, Ontario, Canada, a vital link bridging the lithium mining in the north with downstream EV battery manufacturing markets in the south. Avalon has acquired an industrial site which has existing road, rail, deep-water port, and utilities services for the plant.

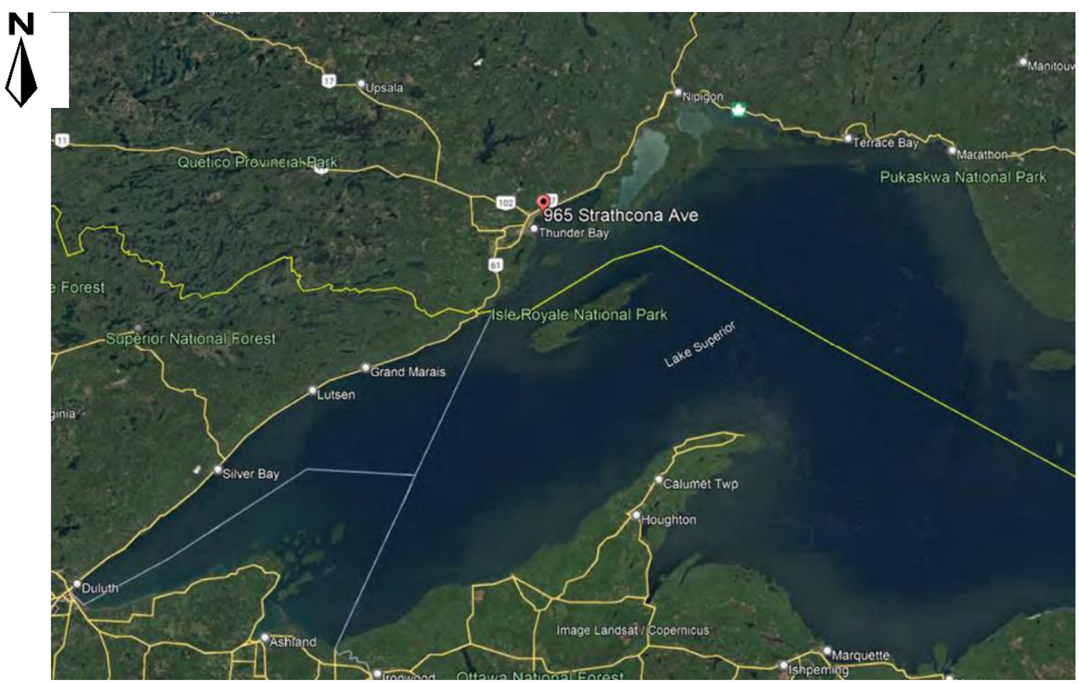
Lake Superior Lithium Project will involve building a lithium hydroxide processing facility that includes a number of unit areas such as spodumene receiving via rail or port, spodumene storage, calcination, hydrometallurgical plant and analcime storage & loadout.

Calcination of raw spodumene feed converts alpha-spodumene to beta-spodumene through a heating process before it is and fed into a hydrometallurgical plant. The commercial product is battery-grade lithium hydroxide monohydrate (LiOH.H2O), which is in short supply and subject to significantly increasing demand from the electric vehicle (EV) industry.

The main parts of the lithium hydroxide processing facility will be based on Metso's proprietary technologies which include calcination, pressure leaching, conversion, and ion exchange (IX) process stages. The design capacity of the commercial facility is 30 kt/year (kt/y) of lithium hydroxide monohydrate.

The Property location, indicated in the map below, is at 965 Strathcona Avenue in Thunder Bay, Ontario, Canada, consider the Project Site.

Figure 2-1– Project Site Location



Source: Google Maps, 2024

3 BASIS OF DESIGN

The PEA was developed by DRA, incorporates Metso's proprietary technologies for the processing facilities, and is based on a projected spodumene concentrate composition since Avalon will be feeding the lithium hydroxide processing facility from multiple spodumene suppliers. Consequently, no test work was performed on a specific spodumene feed, and the proposed feed composition, process flowsheet, and overall recovery are based on Metso's expertise and experience with similar projects.

The assumed concentrate for the PEA represents a typical spodumene composition obtained from dense media separation and flotation beneficiation, with an Li_2O content of 6% by weight. The PEA flowsheet includes a single calciner-cooler to convert alpha-spodumene to beta-spodumene, followed by two parallel hydrometallurgical lines for lithium recovery as $LiOH.H_2O$.

Table 3.1 through Table 3.3 outline the design basis, including plant capacity, anticipated overall lithium recovery, and feed and product specifications. Details on reagents, utilities, effluents, and residue specifications are provided in Appendix A.

Table 3.1 – Plant Capacity and Overall Lithium Recovery

Description	Units	Value
Fresh concentrate nominal feed rate (dry)	t/y	196,000
Spodumene Li_2O head grade	%	6
Steady State LHM production rate	t/y	30,000
Calciner kiln discharge rate	t/h	26
Hydrometallurgical plant feed rate per line	t/h	13
Lithium recovery	%	89.1
Annual operating time	h/y	7,500
Plant availability	%	85.6

Table 3.2 – Plant Feed Specifications

Description	Units	Value
Particle size distribution of spodumene P_{80}	µm	3,000
Concentrate moisture	w/w%	7
Approximate bulk density (approximate)	t/m^3	0.8 -1.02
Angle of repose (approximate)	degree	34 - 45
alpha-Spodumene specific heat (approximate)	kJ/kgºC	0.8 - 1.02
Li_2O in spodumene concentrate	%	6
Composition based on 6.0% Li_2O concentrate		
Spodumene ($LiAlSi_2O_6$)	%	74.7

Description	Units	Value
Albite ($NaAlSi_3O_8$)	%	5
Muscovite ($KAl_2(AlSi_3O_{10})(OH)_2$)	%	3
K-Feldspar ($KAlSi_3O_8$)	%	1
Apatite ($Ca_5(PO_4)_3F$)	%	1
MnO	%	0.2
MgO	%	0.2
CaO	%	0.3
Fe_2O_3	%	1
Al_2O_3	%	3.3
SiO_2	%	11

Table 3.3 – Final Product Specifications (Dry LHM)

Description	Units	Value
Product Type		$LiOH{\cdot}H_2O$
Product Quality		Battery Grade
Compositions		
$LiOH.H_2O$	wt%	>98
LiOH	wt%	56.5-57.5
CO_3^{2-}	wt%	<0.4
Na	wt%	<0.005
K	wt%	<0.003
Fe	wt%	<0.0007
Cu	wt%	<0.0001
Mn	wt%	<0.001
Mg	wt%	<0.001
B	wt%	<0.005
Zn	wt%	<0.0001
Ca	wt%	<0.002
SO_4^{2-}	wt%	<0.008
Cl^-	wt%	<0.002
Si	wt%	<0.005
Insoluble in HCl	wt%	<0.005
Total Magnetic Impurities	wt%	<0.000005

4 PROCESS PLANT

Avalon is planning to establish a Lithium Hydroxide (LiOH) processing facility, sourcing concentrates from multiple suppliers in the region and beyond. The facility will process raw ground alpha-spodumene via a calcination and downstream hydrometallurgical plant to produce battery-grade lithium hydroxide monohydrate (LHM or $LiOH.H_2O$).

The plant will utilize Metso's proprietary technologies, which includes calcination, pressure leaching, conversion, and ion exchange (IX). Metso will contribute data on the crystallization and drying processes to ensure the production of high-quality LHM.

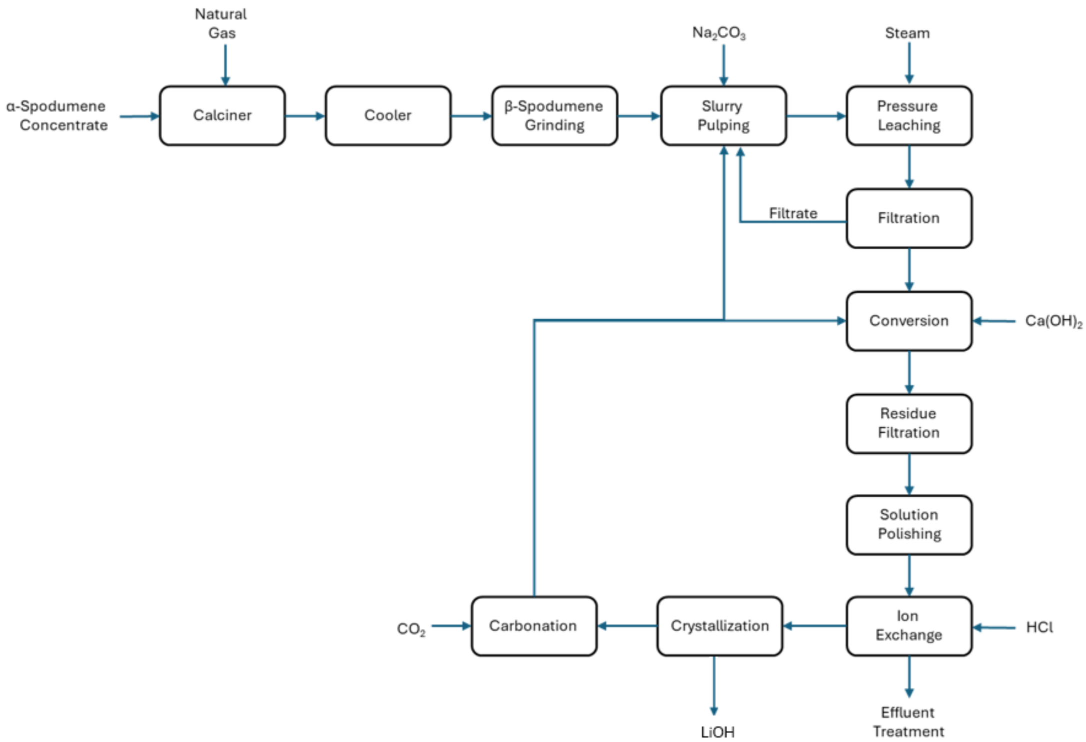
Metso's technologies will enable the creation of a compact, energy-efficient hydrometallurgical plant with minimal chemical usage, aiming to produce 30,000 tonnes per year (t/y) of battery-grade LHM.

A simplified Block Flow Diagram (BFD) of the process is shown in Figure 4-1 and a detailed BFD and mass balance are provided in Appendix B and Appendix C, respectively.

The production process includes the following stages:

- Calcination of alpha-spodumene
- Grinding
- Pulping of the ground beta-spodumene
- Slurry preparation for pressure leaching
- Pressure leaching of the beta-spodumene calcine in an autoclave
- Solid/liquid separation of the pressure leached slurry
- Conversion of the autoclave residue
- Filtering and handling of leach residue
- IX and solution polishing
- Crystallization of LiOH and product handling
- Effluent treatment

Figure 4-1 – Simplified Block Flow Diagram



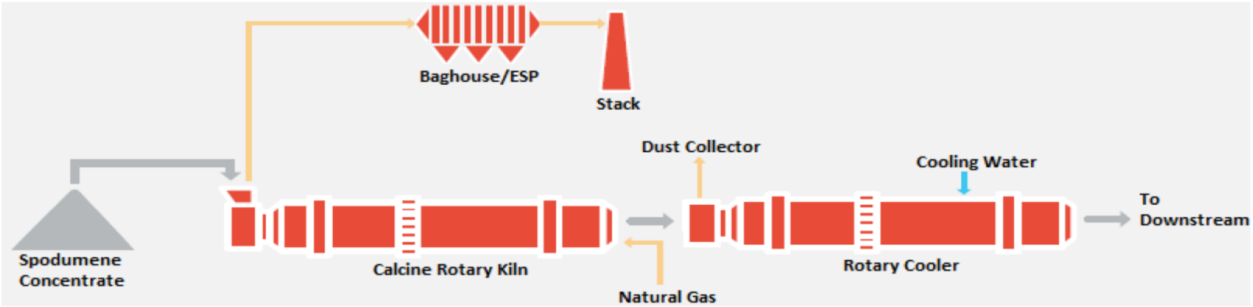
Source: DRA, 2024

4.1 Calcination

In the calcination area, alpha-spodumene concentrate is processed to produce beta-spodumene from which lithium can be recovered. A simplified representation of the calcination process is shown in Figure 4-2. The fresh concentrate is introduced into a rotary kiln, where it is heated to approximately 1050°C (1920°F) using a natural gas firing system. This high temperature transforms the alpha-spodumene into beta-spodumene. During the process, gases flow countercurrent to the material, aided by an induced draft fan (I.D. fan) that directs the gases to a gas cleaning system to remove any fugitive dust. The collected dust is recycled back into the calcination process. The cleaned gases are then released into the atmosphere through a stack.

After exiting the rotary kiln, the material enters a rotary cooler, which reduces the temperature of the hot calcine to approximately 80°C (175°F). Cooling is achieved indirectly by applying water to the cooler shell. The cooled material is then conveyed for further processing. A small dust collector at the rotary cooler handles any sweep gas or leakage from the cooling process.

Figure 4-2 – Spodumene Calcination Process



Source: Metso, 2024

4.2 Wet Grinding of Beta-Spodumene Calcine

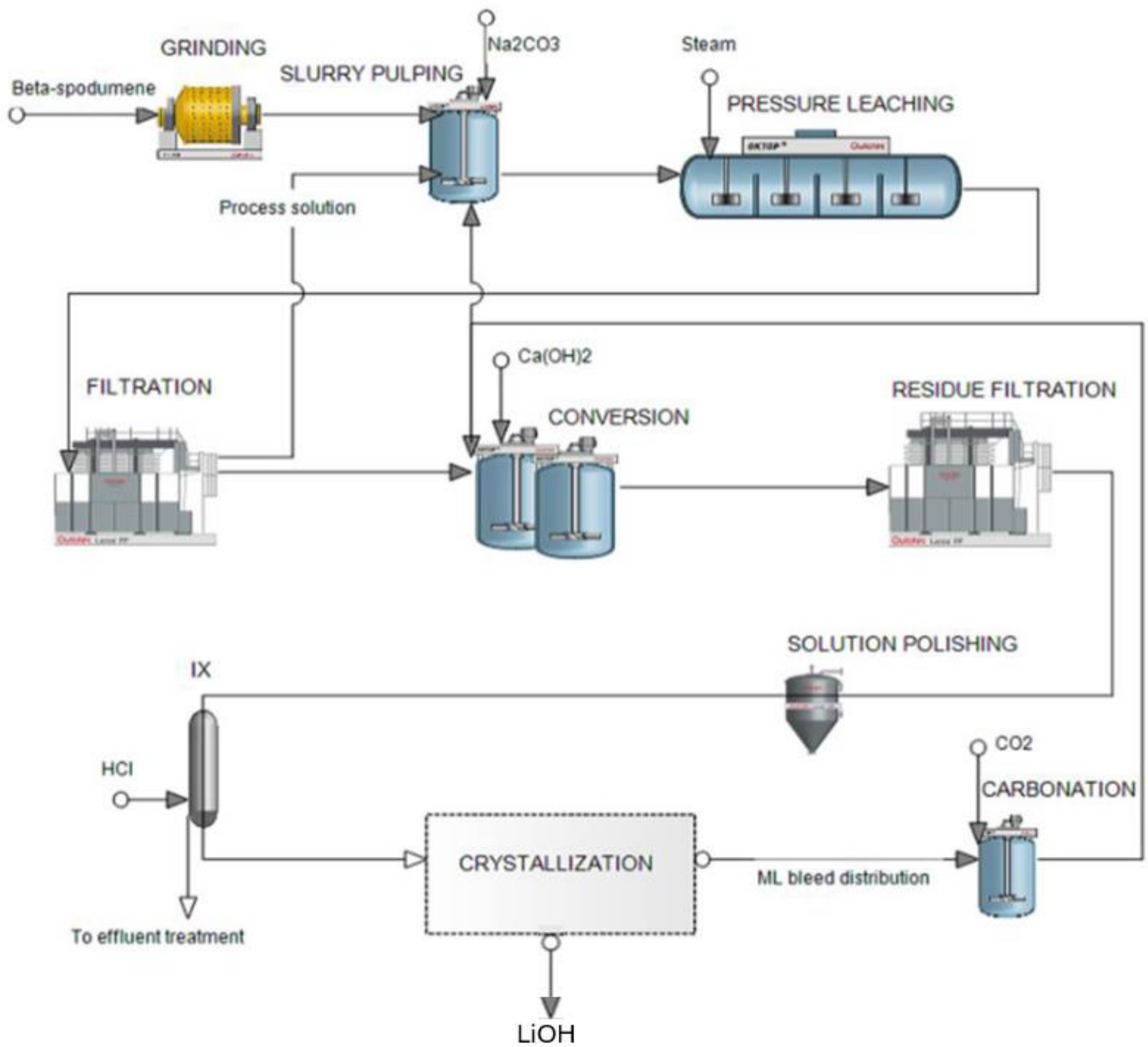
Beta-spodumene feed is transferred from storage bins to the mill feed bin via screw feeders. During calcination, the particle size of the concentrate may increase, so grinding is necessary to achieve a maximum particle size (P_{100}) of 300 µm needed for pressure leaching.

The mill design uses an estimated work index (Wi) of 10 kWh/t. The concentrate is ground in a wet closed-circuit ball mill, which is equipped with a variable speed drive (VSD) to control the mill speed. Material is transported to the mill from the beta-spodumene feed bin using a loss-in-weight feeder system. The mill operates with a 50% w/w solid concentration, with water added based on the incoming feed amount. Filtrate and wash filtrate from the pressure leaching area are primarily used as mill dilution water. A water line with a flow meter is installed on the mill feed chute. After milling, the concentrate is discharged into the mill discharge sump where it is further diluted to 40% w/w to facilitate pumping. Wash filtrate and filtrate are used as pumping liquids. The slurry from the sump is pumped to the beta-spodumene pulpers through grinding circuit screens. Oversized particles are returned to the ball mill feed chute, while the desired undersized particles are directed to the pulping reactors to prepare the slurry for the autoclave leaching process.

4.3 Soda Pressure Leach Process

beta-spodumene is supplied to the hydrometallurgical process from the calcine grinding section. The beta-spodumene storage bins serve as a buffer to manage feed material fluctuations and ensure a steady supply between the upstream calcining process and the downstream hydrometallurgical plant. Figure 4-3 shows a simplified schematic flowsheet of the hydrometallurgical process.

Figure 4-3 – Simplified Flowsheet of Hydrometallurgical Process



Source: Metso, 2024

4.4 Pulping of Beta-Spodumene

The beta-spodumene is transferred as a slurry from the grinding process to the pulping area. In the pulping step, it is combined with circulating liquids - filtrate and wash filtrate from the first stage of slurry filtration—in agitated tanks arranged in series. Solid sodium carbonate is added simultaneously and dissolved, with the mass feed of sodium carbonate adjusted relative to the incoming flow of beta-spodumene from grinding. Sodium carbonate dissolves according to the following reaction:

$$Na_2CO_3(s) \rightarrow 2\ Na^+ + CO_3^{2-}$$

From the beta-spodumene pulper, the slurry is pumped to an autoclave feed reactor and then via a pre-heater into the pressure leaching autoclave. Slurry density in the autoclave feed reactor is monitored and controlled. The pH of the autoclave feed slurry is adjusted using purged mother liquor from the crystallization area. This pH control ensures that any residual bicarbonates from the soda ash or recycling solution are converted to carbonates through the following reaction:

$$NaHCO_3 + 2\ LiOH \rightarrow H_2O + NaOH + Li_2CO_3$$

4.4.1 Pressure Leaching of Beta-Spodumene

The slurry from the autoclave feed tank is pumped to the autoclave through a pre-heater, which uses a direct contact tray system to heat the slurry stepwise with autoclave flash steam. In the pre-heater, the slurry is heated to approximately 160°C using high-pressure (HP) flash steam from the HP flash vessel. The heated slurry is then pumped into the autoclave via a positive displacement pump.

Inside the autoclave, beta-spodumene undergoes pressure leaching at high temperature and pressure. The autoclave contains five mechanically agitated compartments. During the leaching process, beta-spodumene reacts to form lithium carbonate (Li_2CO_3) and analcime solids ($NaAlSi_2O_6 \cdot H_2O$) according to the reaction:

$$2\ LiAlSi_2O_6(s) + Na_2CO_3 + 2\ H_2O \rightarrow Li_2CO_3(s) + 2\ NaAlSi_2O_6 \cdot H_2O(s)$$

The pressure leaching occurs at a maximum temperature of 220°C and a maximum pressure of 22 bar(g). Temperature control in the autoclave is achieved through direct high-pressure steam injection.

Post-leaching, the slurry is released into a two-stage flashing system to reduce pressure and temperature from autoclave conditions to atmospheric levels in a controlled manner. Quench water feed lines are connected to the flashing area to cool the slurry and prevent cavitation caused by rapid pressure drops in the pipelines.

In the HP flash vessel, pressure is first reduced from 22 bar(g) to 7 bar(g) via a pressure reduction valve, which also lowers the temperature from 220°C to 165°C. The vapour generated during this process is routed to an HP pre-heater to heat the autoclave feed slurry. The slurry then flows to the atmospheric (ATM) flash vessel by pressure difference.

In the ATM flash vessel, pressure is further reduced from the HP flash operating pressure to atmospheric pressure through a pressure reduction valve, causing the temperature to drop to approximately 100°C.

The slurry is then pumped to a filter feed cooling reactor where air is injected to facilitate cooling. The hot, moist air from this tank is vented to the carbon dioxide (CO_2) gas scrubber, allowing the slurry to cool and enabling some evaporation of the water. The cooling reactor also acts as a buffer tank.

4.4.2 Off-Gas Scrubbing

Vapour generated during the initial HP flashing step is directed to a pre-heater, which uses direct contact to heat the autoclave feed slurry. Secondary vapour from the ATM flash vessel, along with smaller amounts of off-gas vapour from the pre-heater and autoclave, is sent to an off-gas scrubber.

Leaching gases, including off-gases from the pre-heater, autoclave, and secondary flashing, are collected and treated in a venturi gas scrubber. Solids carried over in the off-gas are removed by spray water through nozzles into the venturi throat. This wash water is collected in the scrubber's internal reservoir and recirculated to the nozzles. Fresh make-up water is added to the reservoir based on the cooling demand, which is monitored by temperature measurements of the wash liquid in the scrubber circuit. Regularly, a bleed stream from the wash water circulation is pumped out to eliminate solids and dissolved impurities. The scrubber water is then sent to the filtering area for use in cake washing, while the scrubbed gas is released into the atmosphere.

4.4.3 Soda Leach Residue Filtration

The leach slurry is transferred from the cooling reactor to an agitated filter feed tank equipped with cooling coils, where it is further cooled to 80°C using cooling water. The slurry is then pumped from the filter feed tank to the filtration system.

Leach residue is separated using two pressure filters operating in parallel. Each filter cycle, which lasts approximately 10 to 15 minutes, includes stages for filtration, cake washing, pressing and air drying, cake release, and cloth washing. To ensure effective washing and minimize lithium carbonate solubility, washing is performed at 80°C. If fresh water is required for cake washing, it must be pre-heated in a heat exchanger. Used cloth wash water is recycled back to the cake wash tank for reuse.

Filtrate and some of the wash water are returned to the calcine grinding and pulping areas, while the remaining wash water is directed to effluent treatment to manage the leach circuit water balance and control soluble chloride levels in the solution.

The leach residue filter cake, which contains mainly analcime ($NaAlSi_2O_6.H_2O$), lithium carbonate, quartz, and other gangue minerals and approximately 30 w/w% moisture, is then conveyed to the conversion process.

4.4.4 Lithium Hydroxide Conversion

Leach residue cakes from the soda leaching pressure filters are initially broken down using a twin-screw mixer, which then feeds the filter cake pulper. The pulper, equipped with an intensive mixer, is designed to expose particle surfaces before conversion. The cake is pulped using recirculated wash filtrates from leach residue filtration, along with some make-up water. Mineral slurry, lime slurry, and wash water from the leach residue filtration are introduced into the conversion step reactors. Calcium hydroxide is added in proportion to the incoming filter cake mass. Conversion occurs at approximately 40 ˚C to facilitate the solubilization of aluminum and silica.

Additionally, a portion of the LiOH crystallization mother liquor purge is recycled into the conversion process to manage aluminum, silica, and carbonate concentrations in the crystallization circuit. The lithium concentration in the conversion process is maintained at around 10 g/L, with some make-up water added as needed. The Li_2CO_3 formed in the autoclave reacts with $Ca(OH)_2$ according to the following reaction:

$$Li_2CO_3(s) + Ca(OH)_2(s) \rightarrow 2\ LiOH + CaCO_3(s)$$

4.4.5 Leach Residue Filtration and Drying

After the conversion process, the slurry is directed to leach residue filters for solid-liquid separation. Two pressure filters operating in parallel handle the separation. Each filter cycle, lasting approximately 10 to 15 minutes, includes stages for filtration, pressing, cake washing, additional pressing and air drying, cake release, and cloth washing. Condensate from the crystallization process, along with any necessary make-up fresh water, is used for cloth and cake washing. The spent cloth wash water is recycled back into the cake washing stage.

Filtrate and wash filtrates are gathered in tanks and pumped to IX. Wash filtrates is also returned to the conversion feed tank to replenish the conversion feed slurry. Dilute wash filtrate is utilized for pulping and suspension of the first filter cakes, lime slaking, lime milk preparation, and polishing filter cake discharge. Wash and dilute wash filtrates are separated at a ratio of approximately 35:65, with the stronger wash filtrate being the first output. This strong wash filtrate containing concentrated LiOH solution, is protected from air and CO_2. The filter manifold flushing step initially uses the strong wash filtrate.

The leach residue filter cake, which primarily consists of analcime ($NaAlSi_2O_6.H_2O$), $CaCO_3$, quartz, and other gangue minerals, is discharged with approximately 30% moisture content. The filter cake is then collected from the pressure filters onto a conveyor that discharges into the chute feeding the rotary dryer. The dryer is heated directly by burning natural gas in air supplied by the primary fan. Dilution air is provided by an additional fan. The combusted gas with entrained dust from the dryer is directed via ducting through a dust collector by means of an I.D. fan. The gas discharged from the fan is directed via a stack to the atmosphere. Dried product discharged from the rotary dryer and dust from the dust collector are pneumatically transferred by pneumatic transfer blower to the dried leach residue storage building.

4.4.6 Secondary Conversion

LiOH filtrate from the pressure filtration is mixed with a small amount of $Ca(OH)_2$ slurry during the secondary conversion step. This process aims to precipitate soluble aluminum, silicate, and carbonate by introducing an excess amount of lime. The secondary conversion occurs at the natural temperature of the filtrate, around 40°C. During this step, the solid concentration is adjusted to approximately 2% with the addition of lime milk. Additionally, a portion of the LiOH crystallization mother liquor purge is recycled into the secondary conversion to manage the aluminium, silicon, and carbonate concentrations within the crystallization circuit.

4.4.7 POLISHING FILTRATION

The slurry from the secondary conversion is processed through a polishing filtration stage to remove suspended solids from the LiOH solution before IX and crystallization. This polishing filtration occurs in two stages, utilizing both a filter press and LSF-type polishing filters, with each type having one unit in operation and one on standby.

The solution is continuously pumped through the operating filter press. The filter cycle involves filling, filtration, initial pressing, cake washing, secondary pressing, air drying, cake release, and cloth washing. The filling time for one filter is approximately 90 minutes, with the entire cycle lasting around 105 minutes. The filter cake is then discharged into a pulper. Condensate from the crystallization process, along with any necessary make-up fresh water, is used for washing the cloths and cake. This wash water is also employed in repulping the cake and preparing the cake slurry from the polishing filtration stages.

Filtrate from the first polishing filtration is redirected to the secondary polishing step to ensure that no solid residues remain in the solution before it proceeds to IX. During secondary polishing filtration, the first ~10 minutes of filtrate is recycled back to the polishing filter feed tank to help form a thin cake on the cloths, thereby improving polishing efficiency. The filtered solution is then stored in the IX feed tank.

The filtration cycle lasts about 33 hours. After forming a cake of approximately 4 mm on the filter cloth, the feed liquid is drained from the filter vessel, and the cake washing cycle begins. Initially, the vessel is filled with wash filtrate from the leach residue filtering stage and then to allow air blowing to slurry the cake. Pressurized air is used to detach and slurry the cakes. Following slurrying, the vessel is drained again, and the cloths are backwashed and spray-washed with warm condensate water. The backwash slurry, including the cloth wash waters, is used in the pulping of the cake from the first polishing filtration. The polishing filter slurry is then pumped back to the conversion reactor.

4.4.8 ION EXCHANGE

After conversion, the LiOH solution undergoes crystallization, first passing through an IX to remove multivalent metal ions (primarily Ca^{2+}) from the solution.

The IX process involves three fixed-bed columns connected in series through a network of piping and valves. When the first column reaches its breakthrough capacity with metals, it is taken offline for regeneration.

The regeneration cycle begins with a pre-wash stage, where 2 M sodium hydroxide (NaOH) solution is introduced to the column to displace most of the lithium bound to the resin with sodium ions. The output from this displacement, which is a dilute LiOH solution, is returned to the IX feed tank.

Following the pre-wash, the column undergoes a first displacement wash with deionized water. The output from this wash, a dilute NaOH-LiOH solution, is collected in the first wash water tank. This spent wash solution is utilized for slurrying recovered Li_2CO_3 cakes in the crystallization process and for inline dilution of the crystallization area mother liquor purge. The slurried Li_2CO_3 cakes are then returned to pressure leaching via carbonation.

A brief backwash with deionized water follows the first displacement wash to cleanse the resin bed, removing air bubbles and potential channelling. This backwash return water is also collected in the first wash water tank and recycled back to the crystallization area.

The metal elution is performed using an excess of 2 M hydrochloric acid (HCl) solution, which converts the resin functional groups to their acid form. The resulting acidic eluate, containing mainly calcium, sodium, and potassium chlorides, is sent to effluent treatment.

Following elution, the column undergoes a second displacement wash with deionized water. The output from this wash, a dilute HCI solution, is primarily used to prepare a dilute HCl solution. Any remaining wash water is used during the column backwash stage.

The resin is then neutralized to its lithium form using process LiOH solution taken from the IX column product flow output. The neutralization step is carried out at a stoichiometric ratio relative to the resin volume, producing water as an output. This water is used for slurrying recovered Li_2CO_3 cakes and for dilution in the crystallization areas.

All IX chemical dilutions are performed with deionized water. Flow measurements control the flow values and amounts of IX regeneration liquids, while pH and/or conductivity measurements from the column output monitor and alert if the liquid feed amounts are adequate for each stage. After regeneration, the column is reconnected as the final column in the series.

The total IX cycle lasts for approximately 24 hours, with the regeneration cycle taking approximately 4 hours.

4.4.9 Crystallization Purge Liquor Treatment

The crystallization mother liquor contains soluble impurities such as sodium, potassium, aluminum, silicon, and carbonate from the two-stage leach process. Therefore, the liquid must be purged or bled from the crystallization area. The rate of purging or bleeding is determined by the concentrations of soluble impurities (primarily Na^+, K^+, Cl^-) in the crystallization circuit. This purge is then directed to three areas in the upstream process: pressure leaching, carbonation, and secondary conversion.

Part of the purge treatment involves precipitating lithium carbonate from the concentrated LiOH mother liquor, as the soda leach circuit consumes little to no strong base LiOH. This portion of the mother liquor recycle transfers soluble sodium and potassium to the pressure leaching stage, where they can react with beta-spodumene to extract lithium.

Another portion of the crystallization mother liquor purge is directed to carbonation to neutralize excess hydroxide. After neutralization, lithium carbonate is returned to the pulping process. The remaining portion is sent to secondary conversion reactors to return soluble aluminum, silica, and carbonate to the polishing step.

4.4.10 Carbonation of the Crystallization Mother Liquor Bleed Stream

In the carbonation step, CO_2 is fed into the mother liquor bleed from crystallization in two series-connected mixed tank reactors, with the pH carefully controlled. Lithium carbonate precipitates from the concentrated LiOH solution through the following reaction:

$$2\ Li^+ + 2\ OH^- + CO_2(g) \rightarrow Li_2CO_3(s) + H_2O$$

During this process, soluble metal hydroxides react with CO_2 to form soluble carbonates, leaving soluble impurities in solution while precipitating out lithium as shown in the following reaction:

$$2\ NaOH + CO_2(g) \rightarrow Na_2CO_3 + H_2O$$

Carbonation is performed at an elevated temperature to reduce lithium solubility, and the naturally high temperature of the mother liquor makes it suitable for this process. After carbonation, the lithium concentration in the solution is reduced to less than 2 g/L. The resulting slurry is then recycled to the soda leaching stage, specifically to the beta-spodumene pulpers.

The carbonation off-gases are scrubbed in a CO_2 gas scrubber. However, off-gas production is minimal due to the efficient dispersion and immediate reaction of CO_2 with the solution. The solution has the capacity to absorb up to twice the amount of CO_2, forming bicarbonates from the produced carbonates. Despite this, the high carbonation temperature (80°C to 90°C) promotes the formation of insoluble lithium carbonate solids, which is preferable to avoid additional neutralization reagent consumption (LiOH/NaOH) for pH control in the pressure leaching circuit.

4.4.11 Condensate Recycles

The cooled evaporation condensates returning from the crystallization area are collected in the evaporator condensate tank and used in the pressure filtration steps as well as in the polishing filter plant as cloth and cake washing liquid and other smaller consumption points, such as reagent dilutions.

4.5 Lithium Hydroxide Crystallization

The crystallization plant processes dilute LiOH feed liquor, which is obtained from crude lithium carbonate through a reaction with hydrated lime and subsequent softening to remove calcium. This feed liquor contains some impurities, such as sodium (Na), potassium (K), aluminum (Al), and silicon (Si), necessitating a two-stage crystallization process to achieve the desired product purity.

4.5.1 First Stage Crystallization

The process involves several critical stages to maintain precise conditions for producing high purity LHM. Initially, the feed liquor is stored in a large, agitated tank, providing a 12-hour buffer between the IX plant and the crystallization plant. The liquor is then pumped to a preheater at approximately 3% w/w LiOH where condensate from the evaporator and first-stage crystallizer is used for heating. This preheated feed is concentrated in a falling film evaporator to 11% w/w LiOH under atmospheric pressure, with concentration flow rates controlled by monitoring density and boiling point elevation.

The evaporated vapour from the falling film evaporator is purified by a mesh demister, then compressed using a Mechanical Vapour Recompression (MVR) fan to increase the temperature by 10°C before being recycled back to the heater. The MVR fan operation is regulated by a Variable Frequency Drive (VFD) according to plant requirements, with make-up steam used to balance energy. Condensate from the heater is cooled to 50°C in the liquor preheater and reused for de-superheating, as make-up in dissolving processes, and for washing in the crystallizer, optimizing both energy efficiency and process effectiveness.

After concentration, the LiOH is cooled in the feed liquor preheaters and stored, providing a buffer between production stages. The next major step involves the first stage crystallizer, where a forced circulation crystallizer operates under a vacuum of 36 kPa(a) with a liquor temperature maintained at 80°C to promote the crystallization of LHM crystals. Liquor and slurry are circulated through a forced circulation system, and impurities are managed by a controlled purge of mother liquor to prevent solid entrainment and to maintain purity.

Vapours from this process are compressed in two stages for energy recovery, with the fan achieving an overall temperature rise of 18°C. The crystallized slurry is then thickened and dewatered in a centrifuge. The crystals are dissolved in a dissolving tank to allow for recrystallization in the second stage. After dissolution, the liquor is filtered to remove impurities such as Li_2CO_3, which has a low solubility and could contaminate the LHM product. The system employs robust instrumentation to monitor and control impurity levels, ensuring the final product's high purity. The first-stage crystallizer requires substantial mother liquor purging to manage impurity build-up.

The Li_2CO_3 filter cake is recovered in a slurry tank and pumped batchwise back to the upstream plant as a 10% Li_2CO_3 slurry. Wash water from the upstream IX process is used as slurrying solution and to maintain the slurry tank level.

4.5.2 Second Stage Crystallization

Filtered liquor exiting the filter press is directed to the second stage centrate tank, where it is combined with crystallizer mother liquor from the centrate and hydrocyclone overflow. This combined liquor is then fed into the second stage crystallizer, which is designed similarly to the first stage unit.

The required purge from the second stage is significantly lower than that of the first stage due to the reduced impurity levels. This purge is removed from the liquor separator and pumped back to the first stage centrate tank. The necessary energy input is provided by a two-stage MVR fan equipped with VSDs, which compresses the vapours and transfers them to the heater shell.

Crystal slurry density is monitored and controlled, and the slurry is continuously extracted by the slurry extraction pump. It is then sent to a hydrocyclone and a two-stage pusher centrifuge, like the first stage, for dewatering and washing of the crystals.

4.5.3 Plant Washing and Utilities

The crystallization process includes regular maintenance tasks such as washing crystallizers using a fly wash technique to dilute and remove solid build-ups, with a dedicated system available for complete content removal when necessary. Pipelines handling crystal slurries and saturated mother liquor are equipped with hard-piped wash water and automated valves to prevent blockages. Similar washing systems are also installed for centrifuges, which need a continuous flow of wash water. All process pumps are fitted with water-flushed, double mechanical seals and a dedicated seal water system, using demineralized water for both wash and seal water. Cooling and makeup steam are required for various system components, including vent condensers and crystallizers, with steam condensate being recycled. Additional utilities needed include nitrogen, various air supplies, and safety-related water provisions. For descaling operations within the pre-concentrator, a specific system utilizing diluted HCl with a corrosion inhibitor is employed.

4.5.4 Product Dryer

The pure LHM crystals from the second-stage crystallizer are transferred via a screw conveyor to the product dryer.

The product dryer is a circular fluidized bed unit that uses recirculated CO_2-free air for fluidizing and drying. Bed temperature and inlet air temperature are precisely controlled to prevent decomposition and loss of water of crystallization, with the final product temperature maintained between 55°C and 60°C. The upper plenum of the dryer is kept under slight negative pressure to avoid the ingress of ambient air.

The dryer off-gas undergoes two stages of scrubbing for cleaning and cooling. The first stage uses a spray scrubber to quench and cool the gas, condensing excess moisture. An external scrub liquor exchanger removes energy from the system using cooling water. In the second stage, the gas passes through a packed bed scrubber, where fresh make-up water is added to ensure clean scrub liquor. The scrub liquor from the second stage is purged to the first-stage scrubber, with the second stage purge concentration controlled to approximately 9% w/w LiOH. This purge is heated to boiling temperature using hot second stage condensate before being directed to the second-stage centrate tank.

Clean gas is recirculated through a centrifugal fan, passing through a steam air heater before returning to the fluid bed dryer’s inlet wind box. Dryer pressure is managed by purging excess recirculating air to the atmosphere, while air humidity is regulated by the outlet temperature of the first scrubbing stage. The dry product is discharged from the fluid bed dryer via a rotary valve to ensure an airlock. A hollow flight cooling screw conveyor, using cooling water, cools the product to below 40°C before it is discharged to the battery limit.

The gas purge from the dryer is directed to the vent scrubber system. The LHM dryer will be supplied as a vendor package from a specialized dryer manufacturer, with all design details finalized and reviewed in collaboration with the chosen vendor.

4.6 Carbon Dioxide Free Air and Venting

It is crucial to ensure that CO_2-contaminated air does not come into contact with concentrated LiOH solutions. These solutions are highly alkaline and can readily absorb CO_2, leading to the formation of Li_2CO_3. To avoid this, all critical areas are equipped with a CO_2-free air blanketing system that purges normal atmospheric air and provides a CO_2-free environment. This system covers all process equipment, including agitated tanks, storage and centrate tanks, centrifuges, and conveyors.

The blanketing and venting system also helps prevent the emission of concentrated LiOH mist or vapours, which can cause severe irritation. Gases from the LiOH conversion and IX areas are directed to a blanketing gas scrubber. This scrubber treats the gases similarly to a CO_2 scrubber by washing any liquid droplets with circulating water. It consists of an ejector circulation system for gas collection and a column circulation system for releasing output gases to the atmosphere. The resulting gas is moist nitrogen.

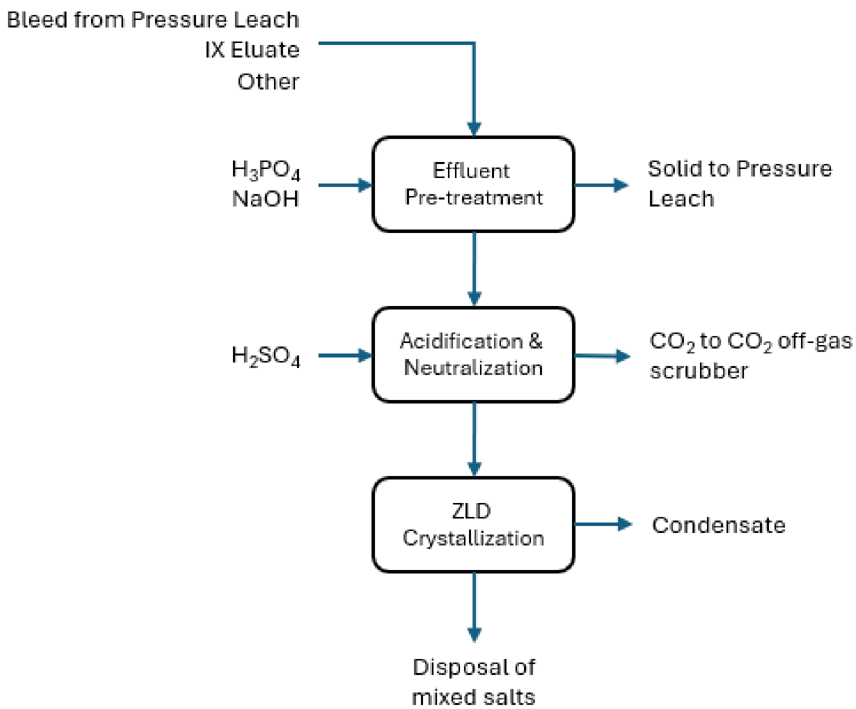
The addition of make-up water to the scrubber is controlled based on the pH of the scrubber circuit. The output water bleed, combined with wash waters from the IX area (collected in the first wash tank), is used for dilution and slurrying in the crystallization areas.

CO_2-free air supply is regulated to maintain a slight positive pressure in each system. All tanks and equipment in the crystallization areas are vented to a central header, which then exhausts to the atmosphere via a jet scrubber system. This scrubber system features a jet venturi that discharges into a collection tank with an integrated packed column. The jet venturi is fed by pressurized scrub water from a dedicated ejector circulation pump. It functions as both the primary scrubbing stage and the source of pressure needed to overcome the packed column pressure drop. An internal tank baffle separates clean scrub water, which is used to supply the column circulation pump, with make-up water added as needed. The liquor purge is drawn from the ejector circulation pump discharge and routed to the second-stage centrate tank.

4.7 Effluent Treatment

The bleed from soda process filtrate and IX acidic eluate are continuously pumped into the effluent storage tank. Additionally, minor streams such as spent wash/scaling removal acids from the falling film evaporator and CO_2 scrubber bleed solutions are directed to the effluent treatment plant. To adhere to Zero Liquid Discharge (ZLD) principles, a ZLD crystallizer plant with pre-treatment stages is required. This setup will process the effluent stream from the upstream process, generating mixed salt cake for disposal and condensate for recycling. A simplified flow diagram is shown in Figure 4-4 of the effluent treatment process.

Figure 4-4 – Simplified Effluent Treatment Process



Source: DRA, 2024

4.7.1 Lithium Recovery

In the effluent pre-treatment stage, lithium is recovered from the effluent liquor through precipitation as lithium phosphate using phosphoric acid. Concurrently, calcium carbonate or phosphate also precipitates with residual carbonates and phosphate ions. Sodium hydroxide is added to maintain the pH above 10, ensuring the effective precipitation of phosphates and carbonates despite fluctuations in the effluent feed.

The precipitation reactions are as follows:

$$3\ LiCl(aq) + Na_3PO_4(aq) \rightarrow 3\ NaCl(aq) + Li_3PO_4(s)$$

$$CaCl_2\ (aq) + Na_2CO_3(aq) \rightarrow 2\ NaCl(aq) + CaCO_3(s)$$

$$3\ CaCl_2(aq) + 2\ Na_3PO_4(aq) \rightarrow 6\ NaCl(aq) + Ca_3(PO_4)_2(s)$$

The rate and extent of lithium phosphate precipitation are influenced by temperature, given the solubility characteristics of lithium phosphate salt. Calcium precipitates, which are also insoluble, are assumed to precipitate completely.

Phosphate, in the form of phosphoric acid, is added to the agitated reactor tanks. The dosing rate is ratio controlled to the flow of the solution. The naturally high temperature of the solution aids in the recovery of lithium phosphate precipitate. Concurrently, the pH is maintained above 10 with concentrated NaOH to support the precipitation of both lithium phosphate and calcium carbonate/phosphate.

The resulting slurry is pumped into the agitated filter feed tank, where it is fed to the filter press via a variable speed pump, operating on a batch-wise filtration schedule. The filtration cycle includes filling, filtration, cake squeezing, washing, drying, and discharge. Initially, the filtrate, which may be slightly cloudy, is recycled back to the filter feed tank.

The upstream feed tank and downstream filtrate tank act as buffers during periods when the filter press is engaged in cake squeezing, drying, or discharge, preventing interruptions in slurry feeding.

The lithium phosphate filter cake is re-slurried in the lithium phosphate slurry tank with solution from the IX area, and then recycled in batches to the upstream pressure leaching plant. A cake washing step is performed to minimize impurities that are recycled back into the upstream process. Water from the washing step is directed to the filtrate tank.

Plant air is utilized for both cake drying and cake squeezing (membrane inflation). A dedicated air receiver supplies the necessary air volumes for these processes.

4.7.2 Acidification and Neutralization

Another pre-treatment step is required before the plant effluent proceeds to the ZLD process, namely, acidification and neutralization. The lithium-depleted effluent may still contain residual carbonate ions, which must be removed through acidification. The acidification is done with sulphuric acid feed, pH controlled to 5.5, as follows:

$$H_2SO_4 + CO_3^{2-} \rightarrow CO_2\ (g) + SO_4^{2-} + H_2O$$

During this process CO_2 gas is generated, similar to what occurs in the effluent feed tank. The generated CO_2 off-gases are vented from the tank to the CO_2 off-gas scrubber.

In the neutralization tank, the pH is monitored, and caustic soda solution is added to adjust the pH to neutral or slightly above neutral. Once the feed liquor reaches the appropriate pH level, it is ready to be pumped from the neutralization tank to the ZLD crystallization process.

4.7.3 Zero Liquid Discharge Crystallizer

The wastewater crystallizer system operates as a forced circulation MVR crystallizer. Feed flow, primarily consisting of sodium chloride and lithium chloride from the neutralization/feed storage tank, is pumped through a heat exchanger to recover heat from the clean distillate before being discharged into the centrate tank. This heat exchanger transfers heat from the hot distillate exiting the crystallizer to the cooler effluent feed, optimizing heat recovery based on the feed temperature.

After preheating, the feed in the centrate tank is mixed with Na_2SO_4. Given the LiCl concentration in the feed, sodium sulphate is added to produce lithium sulphate and sodium chloride. This addition helps to lower the boiling point rise of the concentrated brine in the crystallizer.

The feed solution from the centrate tank is then directed into the crystallizer, where crystals continuously form in the brine slurry. As the brine is heated and flashed, water is removed as vapour, causing the brine to become supersaturated and leading to the precipitation of salts. To manage the level of recirculating brine solids, a bleed is withdrawn from the crystallizer recirculating brine and sent to the final dewatering step. Condensate from the crystallizer is collected in the distillate tank and pumped through the preheater for reuse in the process.

4.8 Auxiliaries

In addition, some auxiliary systems and utilities are needed at the plant site:

- 30% to 50 % NaOH solution tank and dilution system to ~4% solution
- 33% HCl solution tank and dilution system to ~7% solution
- Reagent solution preparation packages
- Lime slaking and lime milk preparation package
- Compressed air distribution systems: plant and instrument air
- Sealing water system for autoclave mixers, using fresh water
- Sealing water system for pumps, using fresh water (and demi water in crystallization)
- Condensate collection tank for steam heat exchanger condensates
- Fresh water tank for water distribution
- Demineralized water tank for demineralized water distribution
- Cooling water supply and return
- CO_2-free air distribution
- High/medium/low-pressure steam system and distribution
- Potable water distribution to emergency showers
- Safety shower system, using fresh and potable water
- Fire water system, using fresh and potable water
- Booster blower system, using cooling water for cooling off gas
- Electrical power supply and substation.

4.9 Site Layout and Process Plant Plot Plan

The site layout overlain on the area map can be seen in Figure 4-5. The diagram showing the layout of the main process equipment within the buildings can be seen in Appendix D.

Figure 4-5 – Aerial View of Site Area with New Facilities Overlain

Source: DRA 3D Model Rendering, 2024

5 SUPPORTING INFRASTRUCTURE

5.1 Roads

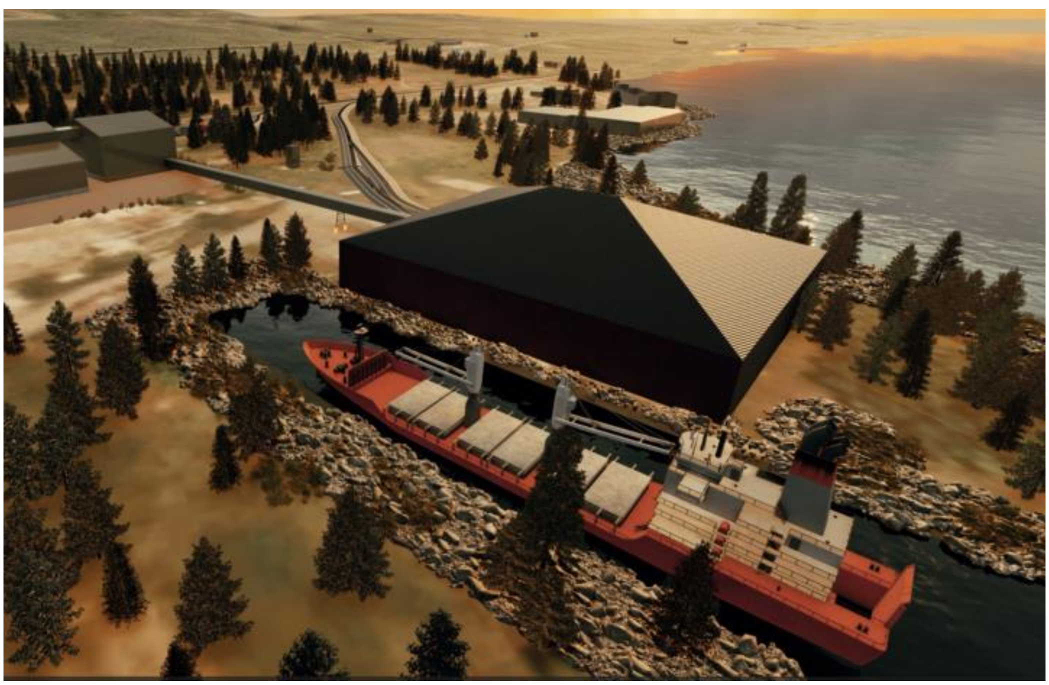
The Property is accessed via Shipyard Road which intersects Strathcona Avenue. Strathcona Avenue is linked to the Trans-Canada Highway (Highways 11 / 17) by Spruce River Road, 2.7km east of The Property.

Internal roads for The Property will be developed to access all buildings for personnel access and commercial deliveries.

5.2 Rail and Port

An existing deep-water port will provide access to The Property via Lake Superior. The deep-water port will require refurbishment before spodumene concentrate can be delivered through it with Great Lakes freighters. An existing warehouse adjacent to the deep-water port will be utilized for offloading spodumene concentrate from Great Lakes freighters. The warehouse will be refurbished and retrofitted with material handling equipment to receive the spodumene concentrate.

Figure 5-1 – Conceptual 3D Rendering of the Deep-Water Port and Warehouse



Source: DRA 3D Model Rendering, 2024

A CN Rail line runs along the north of The Property, dead ending just east of The Property. A rail spur from the rail line currently enters The Property from the northeast corner. The main spur splits into multiple spurs and enters the existing warehouse adjacent to the deep-water port. Additional spurs will be added to allow for spodumene concentrate offload and analcime load out. The existing spurs entering the warehouse will require refurbishment. Rail will be the primary means used for the delivery of spodumene concentrate when the lithium mines in the region come online in the years to come. Rail will also be utilized to transport reagents to site and byproducts from site.

Figure 5-2 – Conceptual 3D Rendering of Rail Lines Entering Warehouse and Spodumene Concentrate Off-Load Facility

Source: DRA 3D Model Rendering, 2024

5.3 Spodumene Concentrate Storage

During the offloading of spodumene concentrate from rail and deep-water port the concentrate is conveyed to the concentrate storage building. The building will have a storage capacity of approximately 50,000 t of spodumene. When full, the storage facility will provide storage for up to three months of feed to the calcination process. Spodumene is anticipated to be delivered in lots; before processing the lots will need to be sampled to determine the Li_2O grade and moisture content and surveyed for volume. In some cases, the lots may need to be settled with the supplier via umpire. The process can take multiple weeks to conclude before the spodumene concentrate can be processed. Ample capacity is therefore required in the spodumene concentrate storage facility.

The spodumene concentrate will be reclaimed from the stockpile using a combined portal reclaimer and conveyed to the calciner for pyrometallurgical treatment. An example of such a reclaimer can be seen in Figure 5-3.

Figure 5-3 – Sample Image of a Combined Portal Reclaimer

Source: Schade Aumund Group, 2024

5.4 Cooling Water

Cooling water will be required to cool the beta-spodumene after calcination and will also be required in various processes within the hydrometallurgical plant. The cooling water will be cooled using cooling towers, one for the pyrometallurgical section of the process and one for the hydrometallurgical section of the process.

Figure 5-4 – Conceptual 3D Rendering of Cooling Tower for Pyrometallurgical Process

Source: DRA 3D Model Rendering, 2024

5.5 Fresh Water

Fresh water will be required for the process and will be sourced from a freshwater intake in Lake Superior.

5.6 Demineralized Water Plant

Demineralized water is required for the IX, crystallizer and the steam generating boiler systems. Demineralized water will be generated in a reverse osmosis plant with a capacity of 800 m^3/day.

5.7 Potable Water and Sewage

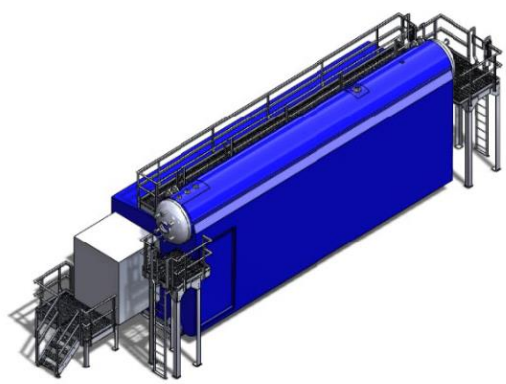
The Property is serviced by Thunder Bay municipal sewer and potable water utilities.

5.8 Steam Boiler

High pressure steam will be required for the pressure leaching process for injection into the autoclaves. Medium pressure steam will also be required for the autoclaves and for the startup sequence. Low pressure steam will be required in the crystallizer area.

The steam requirements will be generated with a steam boiler system with a capacity of 18 t/h @ 31 bar(g).

Figure 5-5 – Conceptual 3D Rendering of Steam Boiler System



Source: Babcock and Wilcox, 2024

5.9 Plant, Instrument and Carbon Dioxide Free Air

Plant air will be utilized in the flashing process post-pressure leaching and within the beta-spodumene feeder system. Plant air will be generated with an air compressor in line with filters and an air receiver for distribution. The plant air compressor will have a design capacity of 2,790 Nm^3/h @ 125 psig.

Instrument air will be supplied to the instruments. The instrument air will be generated using an air compressor in line with a dryer, filters and an instrument air receiver. The instrument air compressor has a capacity of 1,570 Nm^3/h @ 115 psig.

A third compressor will service both the plant and instrument air systems as a redundant spare.

CO_2-free air will be required for blanketing gas when LiOH is present to prevent it from converting to lithium carbonate. CO_2-free air displaces atmospheric air in tanks and vessels. CO_2-free air will be generated using a compressor of the same size as the instrument air compressor, the compressor is in line with air filters, air dryer and a CO_2 stripper which will reduce the CO_2 content to sub 10ppm. The CO_2-free air will be stored in an air receiver for use in the process. The CO_2-free air compressor will have a capacity of 1,570 Nm^3/h @ 115 psig.

All air compressors will be oil free; water cooled and operate using VSDs.

5.10 Analcime Storage

After drying, analcime will be conveyed to the analcime storage building. The building will have capacity for approximately 66,000 t of analcime. The building will provide storage for up to 12 weeks at full production.

Figure 5-6 – Conceptual 3D Rendering of Analcime Storage and Rail Loadout

Source: DRA 3D Model Rendering, 2024

5.11 Office Building and Laboratory

An administrative office and analytical laboratory will be located on site north of the railroad tracks. The administration building will house offices, kitchen / lunchroom, conference rooms and restroom facilities. The laboratory will be used to test incoming lots of spodumene as well as product and byproduct streams and internal streams within the process to ensure quality is met throughout the process.

Figure 5-7 – Conceptual 3D Rendering of Administrative Office

Source: DRA 3D Model Rendering, 2024

5.12 Electrical Infrastructure

The section provides a basic outline of electrical requirements to supply power to the new facilities.

The total estimated load is presented in Table 5.1.

Table 5.1 – Process Plant Load Summary

Name	Mechanical power Installed	Electrical Power	Total no. of motor loads	Total motor loads operating	Voltage	Peak Demand	Peak Demand	Peak Demand	Emergency load	Average Power	Average Power	Average Power
	kW	kW			V	kVA	kW	kV Ar	kW	kVA	kW	kVA r
LV Loads	11,444	7,762	416	324	575	9,803	8,881	4,151	2,129	7,843	7,105	3,321
MV Loads	4,397	2,443	2	2	4000	4,885	3,908	2,931	0	3,908	3,127	2,345
All Loads	***15,841***	***10,205***	***418***	***326***		***14,619***	***12,789***	***7,083***	***2,129***	***11,696***	***10,231***	***5,666***
Contingency + Design Growth + Services	3,960	2,551				3,655	3,197	1,771	532	2,924	2,558	1,417

Name	Mechanical power Installed	Electrical Power	Total no. of motor loads	Total motor loads operating	Voltage	Peak Demand	Peak Demand	Peak Demand	Emergency load	Average Power	Average Power	Average Power
	kW	kW			V	kVA	kW	kV Ar	kW	kVA	kW	kVA r
Total Loads	19,801	12,756				18,274	15,987	8,853	2,662	14,619	12,789	7,083

Electrical power for the project will be provided by the main substation. The main substation is supplied at 115 kV from the Hydro One power transmission system. The main substation will comprise dual 115-13.8 kV, 15/20 MVA transformers. Single Line Drawings G792$_5$-E0$_1$-01002 and G792$_5$-E0$_1$-01003 show the overall power distribution to the process plant, they can be seen in Appendix E.

A 13.8 kV switchgear line-up will be installed in a new E-house 7110-ER-001 installed at the main substation. Power to the new process plant additions will be distributed at 13.8 kV via cable trays. Power for process loads will be stepped down from 13.8 kV to 600 V by power transformers located adjacent the new E-houses.

E-houses will be supplied complete with medium voltage switchgear, low-voltage MCC, VFDs, battery chargers/battery banks, I/O racks and control panels, and fully serviced with fire-alarm panel, lighting, heating and air conditioning. The fire-alarm panel will report a fire trouble or alarm to the main control room via the communications network. E-houses will be supplied with handheld fire extinguishers.

E-houses will be installed on reinforced concrete footings and pedestals, elevated 2.2 m above grade for bottom-entry cables.

Power, control and signal cables will generally be installed in cable tray supported by overhead cable/pipe racks.

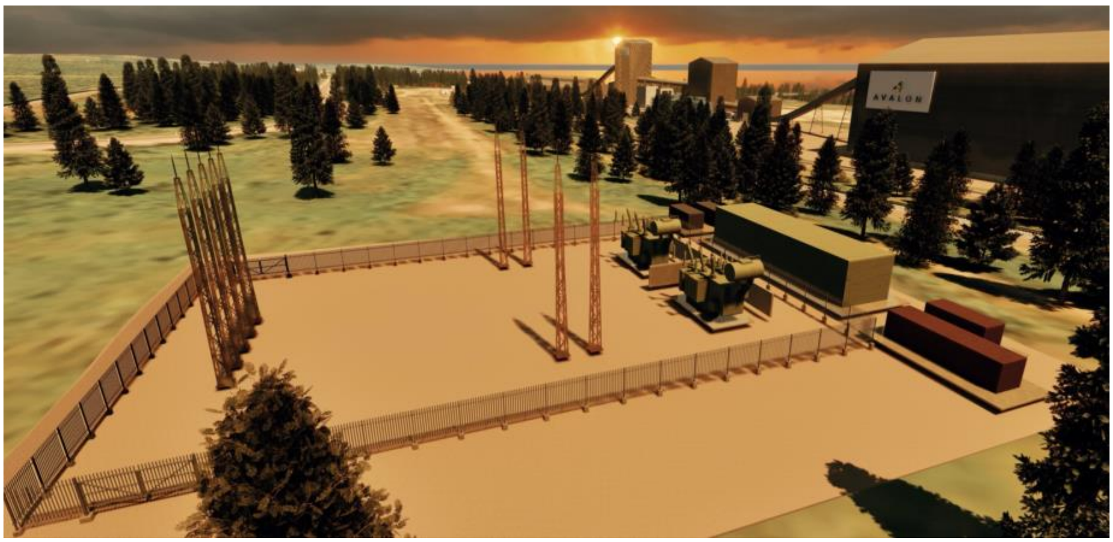
Power transformers located adjacent to the E-houses, will be separated by concrete block walls with 2-hour fire ratings. Oil filled transformers will be installed on reinforced concrete oil containment pads. Dry type transformers will be installed indoors within ventilated transformer vaults.

Emergency backup power generators will be installed for emergency power supply to essential loads upon loss of utility power. Power demand for emergency power is shown in Table 5.1. Emergency generators will consist of diesel engine-driven generators. The generators are supplied fully assembled within a weatherproof acoustic enclosure complete with main breaker and 24-hour fuel storage in the steel base. Upon sensing loss of normal power, an automatic transfer switch will start the emergency generator and switch the power supply from normal to emergency power once the generator reaches full voltage.

An uninterruptable power supply (UPS) will provide back-up power to critical control systems. Battery power packs will supply backup power to the fire alarm system and emergency lighting.

Due to the potential for freezing liquids in pipes or tanks, piping and tanks which carry or hold liquids subject to freezing will be electrically heat traced.

Figure 5-8 – Conceptual 3D Rendering of Electrical Substation



Source: DRA 3D Model Rendering, 2024

6 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

This section of the report was prepared entirely by SLR Consulting, who were retained separately by Avalon specifically for their expertise in the subject matter. DRA integrated this section as provided by SLR into the overall report and edited it for consistency and continuity only.

Avalon is advancing planning and design of its full-scale lithium hydroxide processing facility within its Lake Superior Lithium Project at its project site in Thunder Bay, Ontario, Canada.

Table 6.1 shows a preliminary summary of the key process inputs, outputs, and by-products of the lithium hydroxide processing facility. The lithium hydroxide processing facility will also include associated infrastructure for access (onsite road, rail and shipping), power supply, storage, laydown, and office buildings (collectively referred to as the Lake Superior Lithium Project).

Table 6.1 – Preliminary Key Inputs, Key Outputs and By-Products

Lithium Processing Plant*		
Key Inputs / Raw Materials	**Key Outputs / Products**	**By-products / Waste**
Spodumene concentrate from mine (raw material) Reagent chemicals (sulphuric acid, sodium carbonate, sodium hydroxide, lime, hydrochloric acid, phosphoric acid, carbon dioxide) – in enclosed storage Water (for processing and utilities) Power (kiln needs natural gas, steam is needed for boiler and will use natural gas)	$LiOH.H_2O$ – due to the strong odour associated with this material it will be stored in enclosed storage onsite	Residue sand (analcime) – may be able to sell to construction, cement industry or other compatible use, send to licensed operational landfill offsite or back to source mine site (generally considered “clean”) General and hazardous waste – will use a licensed hauler and managed at a licensed facility offsite Atmospheric emissions – steam from the cooling process, CO_2, NOx, SOx (scrubbers will be used to reduce emissions) Zero liquid discharge - effluent will be treated and condensate recycled within the processing plant and ‘cake’ disposal in licensed facility

6.1 Environmental Studies and Issues

6.1.1 Land Tenure

The Project Site (965 Strathcona Avenue) is located within the City of Thunder Bay along the northern shore of Lake Superior, centred at Universal Transverse Mercator (UTM) coordinates of 339855 m East and 5370875 m North (North American Datum 1983, Zone 16U) (CSL 2024a). Access to the Project Site is provided via Strathcona Avenue, which parallels the rail corridor and the shoreline of Lake Superior and travels east from Thunder Bay, followed by Shipyard Road travelling southeast towards Lake Superior and connecting to the driveway of The Property.

The Project Site is owned by Avalon, through a wholly owned subsidiary, which purchased it in mid-June 2023. It was formerly a pulp and paper facility; much of the original infrastructure has been demolished, although some of it remains.

The Project Site is serviced by Thunder Bay municipal sewer and potable water utilities. Electrical power and natural gas are also connected.

6.1.2 Local Land Use

Local adjacent land uses include:

- Other industrial properties, including a water treatment facility for Thunder Bay (Bare Point Water Treatment), area adjacent to the Project Site to the north and south. The Bare Point Water Treatment to the north is the single source of municipal residential drinking water for the City of Thunder Bay, servicing a population of over 100,000. Lake Superior is the source with the intake, approximately 750 m offshore.
- Approximately 500 m to 1000 m west of the Project Site boundary are residences and a golf course.
- Between the Project Site and these residences are road corridors, railway corridors including an overpass crossing at Strathcona Avenue and level crossing on access road to the Project Site, and powerline corridors. Power transmission Line (115kV), CN rail line corridors, and Strathcona Avenue are immediately adjacent to the northwest.
- Immediately to the east of the Project Site is Lake Superior.

6.1.3 Topography and Environmental Features

The Project Site is located immediately adjacent to Lake Superior and the topography is relatively flat with an elevation of ~184 m above sea level (m asl). The former landfill provides a topographic high of ~194 m asl in the middle part of The Project Site (CSL 2024b). Strathcona Avenue, which parallels the boundary approximately 250 m to the north, has an elevation of 209 m asl. The ground slopes steadily towards Lake Superior from Strathcona Avenue, reaching an elevation of approximately 184 m asl at the shoreline of Lake Superior.

The Project Site is a brownfield site and has not been reviewed to define if it hosts any heritage, cultural, or archaeological resources. This will take place in a future phase of The Project.

6.1.4 Geology

According to the Ontario Geological Survey (OGS) online database (Geology Ontario website July 2024) for bedrock geology of Ontario at a scale of 1:250 000, the bedrock of the area at The Property consists of sedimentary rocks of the Gunflint Formation (including conglomerate, taconite, algal chert, chert, carbonate rocks, and argillite-tuff) and mafic dikes and associated intrusive rocks of the Logan and Nipigon mafic sill complex.

6.1.5 Regional Weather and Climate

Thunder Bay has a humid continental, no dry season, warm summer climate. Based on composite data collected in Thunder Bay (1991-2020), the area's yearly average high temperature is 18.0ºC and average yearly low is -13.4ºC (Environment Canada website, July 2024). The month with the least amount of precipitation is February with 11 mm and the most precipitation is in September with 88 mm (climate station 6048268).

6.1.6 Hydrogeological Setting

Based on information from the most recent monitoring report prepared by CSL Environmental & Geotechnical Ltd. (CSL) (CSL 2024a), hydrogeology around the former landfill is characterized by three distinct groundwater systems: a shallow overburden hydrogeological unit, a confined sand unit beneath a deep clay layer, and a bedrock aquifer. Available borehole logs indicate that the overburden above the clay layer is roughly 2 m thick, and the clay layer is at least 0.3 m thick (where present). It is assumed that the overall groundwater flow direction is towards Lake Superior.

It was assumed (CSL 2024b) that shallow groundwater flow within the overburden unit is influenced by underlying bedrock topography, and that the direction of groundwater flow would generally follow the slope of the topography, which would direct flow towards Lake Superior. Similar inferences were made regarding deep groundwater flow within the confined aquifer beneath the clay layer.

Static groundwater elevations within the monitoring wells (located in the around the former landfill) were measured during the 2023 sampling program (CSL 2024b) and generally show groundwater flowing southeast toward Lake Superior.

Overall, the downgradient groundwater chemistry is generally stable or decreasing and not indicative of leachate from the former landfill (CSL 2024b). The chemical signatures indicate attenuation of chemicals of concern from the former landfill area. The groundwater chemistry seems to be more reflective of background conditions and influenced by the presence of local high organic natural materials including wetlands and a shallow groundwater discharge system. Based on the groundwater chemistry, the reducing (low oxygen) background conditions have imprinted chemical signature on the groundwater system. As such, metals such as iron and manganese, dissolved organic content, and phenols are found to be elevated in groundwater.

6.1.7 Hydrological Setting and Water Quality

Based on available information (CSL 2024b), the lands upgradient of the Project Site mainly consist of undeveloped mixed wooded and grassy areas. Low-lying marshy areas are located cross gradient and downgradient of The Property, closer to Lake Superior.

Stormwater ditches are located along Strathcona Avenue and the railway line, which is diverted south through an open ditch or north of the existing closed landfill through a culvert that crosses The Property. A drainage ditch located on the west side of The Property was installed during closure and is referenced by the Industrial Sewage Works Environmental Compliance Approval (ECA) No. 4452-699RSC, dated March 29, 2005. The ditch directs run-off from the west edge of The Property underneath the access road into a naturally vegetated buffer area at the south end of The Property. The surface water then flows east towards a low-lying marshy area and Lake Superior.

The analytical results for the stormwater samples in 2023 (CSL 2024a) met all applicable Provincial Water Quality Objectives (PWQO) criteria, and generally in compliance with the ECA, except for iron. Iron is suspected to be naturally elevated in the area as it does not appear to be associated with the former landfill leachate signature. In addition, based on satellite imagery, it appears that iron oxidation is occurring at several ponds and wetlands near the Project Site and adjacent properties, suggesting elevated iron concentrations.

6.1.8 Aquatic and Terrestrial Environment

On July 24, 2024, SLR Consulting (Canada) Ltd. (SLR) and CSL personnel conducted a reconnaissance level site visit within the Property.

Overall, the Project Site includes railway corridors that appear to have been dormant for some time and buildings including a brick office building, a warehouse adjacent to the dock, smaller pumphouses and pipeline corridors. There are also various parking/laydown areas that have been intermittently used in the past (to support transmission line construction) and the concrete pad for the previous manufacturing operations. None of the interiors of these buildings and infrastructure was observed during the site reconnaissance.

6.1.8.1 Aquatic Ecosystems

Stormwater/surface water management can affect water quality and overall quality of fish habitat. During the site visit it was noted that:

- The historic “effluent pond” is a j-shaped structure adjacent to the existing dock/pier that was opened to Lake Superior in 2020. The pond is currently filled with surface water and inflow with Lake Superior.
- Two leachate lagoons are located along the Lake Superior shoreline and SLR understands that one was filled with demolition material (2013-2020) and the second (lakeside) was

partially filled with demolition material and currently filled by surface runoff. Historically, water from the two lagoons was pumped to the J-shaped pond; however, this system is no longer operational. Current discharge from the lagoon is unknown; however, a corrugated steel pipe outlet was noted along the shoreline of Lake Superior in the area to the north of these lagoons. Discharge from the pipe was not observed during the site visit and it is unknown if the pipeline is operational.

- Leachate and surface runoff from the existing landfill is collected in ditches along its northeast and southern perimeter. At the time of the site visit, the water was stagnant within these ditches. It was not observed where this collected water would discharge to the environment.
- No other natural drainage ditches/watercourses were observed on The Property at the time of survey.

Much of the collected water forms part of the leachate collection system for the former landfill, was generally stagnant at the time of the site visit and may not be of sufficient quality to support fish. Since they are connected to Lake Superior, the J-shaped pond is presumed to provide fish habitat.

Lake Superior and its shoreline were not included in the reconnaissance site visit.

6.1.8.2 Terrestrial Ecosystems

Due to the significant historic human disturbance, the vegetation communities within the Project Site are cultural in nature. The Property mostly consists of cultural meadow, including the former landfill, central portion of the Property near Shipyard Road, and areas west and east of the J-shaped pond. Cultural meadow within the Property is dominated by herbaceous species including common burdock (*Arctium minus*), tufted vetch (*Vicia cracca*), Canada goldenrod (*Solidago canadensis*), red raspberry (*Rubus idaeus*), Canada thistle (*Cirsium arvense*), and spotted jewelweed (*Impatiens capensis*).

The south end of the Project Site contains cultural woodland consisting of tamarack (*Larix laricina*), white spruce (*Picea glauca*), scots pine (*Pinus sylvestris*), trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), Hawthorn species (*Crataegus spp.*), willow species (*Salix spp*.), and black locust (*Robinia pseudoacacia*). Some dead trees (snags) were present in this area that have attributes suitable for bat habitat, including cracks, cavities, crevices, and loose bark. Some trees have been planted as cultural hedgerows along the Lake Superior shoreline.

The southwest corner of the Project Site contains a disturbed cultural thicket that was recently logged and is now succeeding into shrub/thicket habitat. Surface water collection areas throughout the Project Site have formed shallow marsh/thicket swamp communities consisting of narrow-leaved cattail (*Typha angustifolia*), broad-leaved cattail (*Typha latifolia*), red-osier dogwood (*Cornus sericea*), tamarack, common horsetail (*Equisetum arvense*), bulrush species (*Scirpus spp*.), and reed canary grass (*Phalaris arundinacea*). Most of these shallow marsh/thicket swamp communities appear to have hydrological connections to Lake Superior. The shallow marsh community in the southeast corner of The Property was not assessed in-field due to an abundance of noxious cow parsnip (*Heracleum maximum*) plants along the access trail at the south end of The Property.

The lagoons that have been filled have succeeded into reed canary grass meadow marsh. The portion of the lagoon that remains as open water contains some floating aquatic vegetation, mostly white water lily (*Nymphaea odorata*).

Invasive species within The Property include reed canary grass, black locust, purple loosestrife (*Lythrum salicaria*), scots pine, and white sweet clover (*Melilotus albus*).

A total of 27 bird species were incidentally observed during the site visit. These included species common in northern forest habitats such as white-throated sparrow (*Zonotrichia albicollis*), merlin (*Falco columbarius*), veery (*Catharus fuscescens*), common raven (*Corvus corax*), and red-eyed vireo (*Vireo olivaceus*). Species common to open or shrubby habitats were observed, including clay-colored sparrow (*Spizella pallida*), tree swallow (*Tachycineta bicolor*), alder flycatcher (*Empidonax alnorum*), and savannah sparrow (*Passerculus sandwichensis*). Species common in shoreline and lacustrine habitats were also observed, including double-crested cormorant (*Phalacrocorax auritus*), herring gull (*Larus argentatus*), mallard (*Anas platyrhynchos*), and spotted sandpiper (*Actitis macularius*).

Five barn swallows (*Hirundo rustica*) were observed flying near the J-shaped pond and boat slip, adjacent to the warehouse which has multiple points of entry through an open bay door and collapsed exterior walls. This structure is highly suitable for barn swallow nesting. Barn swallow is a Species of Conservation Concern (SoCC) ranked Special Concern under the provincial *Endangered Species Act*, 2007 and threatened under the federal *Species at Risk Act*, 2002. Several rock pigeons (*Columba livia*) were observed perching on the warehouse exterior and are likely nesting within the warehouse as well. Nests of both species are protected from destruction or disturbance under the Migratory Birds Convention Act, 1994 while they contain eggs or young.

In addition to bird nesting potential within the warehouse, the office building contains at least one broken window which may provide access to the building interior for SoCC bats including little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*). The office building also appears to contain a chimney which, if uncapped, may provide habitat for chimney swift (*Chaetura pelagica*), a bird SoCC which roosts in anthropogenic chimneys. No bats or chimney swift were incidentally observed at the time of the reconnaissance survey.

Evidence of mammal species observed within the Project Site included white-tailed deer (*Odocoileus virginianus*) tracks, beaver (*Castor canadensis*) lodges and tree cuttings, and red squirrel (*Tamiasciurus hudsonicus*) vocalizations.

Ponded surface water is present in shallow ponds and ditches throughout the Project Site with evidence of seasonal surface water flow. These wet areas may provide habitat for terrestrial species including amphibians and marsh birds. A northern leopard frog (*Lithobates pipiens*) was heard calling from the settling lagoon during the site visit.

6.2 Ongoing Environmental Studies

Ongoing environmental data collection will continue to collect information about the Project Site and areas surrounding the planned development footprint that could potentially be affected by the processing activities. These studies allow for the characterization of the biophysical and socio-economic environment prior to any development. In addition, they can be used as a basis for the predictions of potential environmental impacts and appropriate mitigation can be incorporated into the development plan to minimize those potential impacts. Should the development plan change or the footprint of the Project Site change, the baseline studies may have to be adjusted or expanded as appropriate.

6.3 Environmental Permitting

6.3.1 Existing/Current Authorizations and Permits

The Project Site is a formerly active industrial site and has a former (closed and remediated) landfill within its boundaries, as well as an active leachate management system. The following environmental compliance approvals (ECAs) and associated amendments are currently in place:

1. ECA No. 4452-699SRC (March 29, 2005 – Industrial Sewage ECA)
2. ECA No. 5333-6TZG2N (October 4, 2006 – Industrial Sewage ECA)
3. ECA No. A590137 (July 23, 1996 – Waste Disposal Site)
4. Amendment to Provisional ECA No. A590137 (November 9, 2000)
5. Amendment to Provisional ECA No. A590137 (April 21, 2005)
6. Amendment to Provisional ECA No. A590137 (April 27, 2005)
7. Amendment to Provisional ECA No. A590137 (September 30, 2005)
8. Amendment to Provisional ECA No. A590137 (June 21, 2011)

CSL reports (CSL 2024b) that monitoring occurred over the last 10 years; however, the last report submitted to the Ontario Ministry of Environment, Conservation and Parks (MECP) was in 2014. To comply with the ECAs, the next report that should have been submitted for MECP review following the three-year timeframe, covering the years 2014 to 2017; however, there is no record that this, nor subsequent reports, were submitted for review. Since acquiring the property in 2023, Avalon has been working with MECP officials to address this historic noncompliance issue through a series of data collection events and subsequent report writing.

SLR is unaware of any other noncompliance issues at The Property.

The previous operations also held an ECA and associated amendments for air emissions (#4542-4UYQG8) issued April 10, 2001, that has been revoked.

6.3.2 Permit Requirements

Anticipated permit requirements for the proposed Lake Superior Lithium Project are listed in Table 6.2 and Table 6.3. This list is subject to change as additional information is obtained and Project planning and engineering advances. The Lake Superior Lithium Project schedule is also subject to change as the project planning advances and permit requirements are validated.

Table 6.2 – Permits for Proposed Lake Superior Lithium Project - Federal

Permit	Applicable Act	Responsible Agency	Description
Federal			
Fisheries Act Authorization	*Fisheries Act*	Fisheries and Oceans Canada (DFO)	An authorization under Section 35(2) of the Fisheries Act is required if any portion of the Project results in the harmful alteration, disruption or destruction (HADD) of fish habitat. Offsetting for the loss of fish habitat is also required in order to result in no residual effect. Modifications to J-shaped pond, shoreline for the water intake, dock/pier, dredging and temporary berms could be considered a HADD.
Navigable Waters Approval	*Canadian Navigable Waters Act*	Transport Canada (TC)	Carrying out any works in, on, over, under, through, or across navigable waters. Lake Superior is a scheduled navigable water listed in the Schedule to the Act, therefore works conducted there automatically require approval. The dock/pier facilities are open to Lake Superior and are thus navigable, therefore any physical modifications to the dock/pier including construction of a temporary berm and dewatering the channel would require approval.
Species at Risk Permit	*Species at Risk Act*	Environmental and Climate Change Canada (ECCC)	If species at risk are affected by the Project, a permit under the federal *Species at Risk Act* may be required.
Approval to Construct a Railway Line	*Canada Transportation Act*	Canadian Transportation Agency / Transport Canada	Should new railway lines, sidings, or spurs be added, or existing ones substantially modified or relocated, an application under Section 98 of the *Canada Transportation Act* would be required.
Approval to Relocate a Railway Line	*Railway Relocation and Crossing Act*	Canadian Transportation Agency / Transport Canada	Within urban areas, if provincial or municipal authorities cannot reach an agreement with a railway company on the relocation of railway lines, subsection 3(1) of the *Railway Relocation and Crossing Act* (RRCA) permits an application to the Agency for an order to carry out an accepted plan. The RRCA empowers the Agency to order a railway company to do things like: remove railway structures, build new facilities, stop operating on certain lines or allow other railway companies onto their trackage in urban areas.

At this time, it is assumed that a federal impact assessment is not required as the Project physical activities are not listed (referred to as Designated Projects) under Physical Activities Regulations (SOR/2019-285). Designated Projects are subject to a federal impact assessment under *Impact*

Assessment Act (IAA). This includes expansion of the existing marine terminal, if the expansion requires the construction of a new berth designed to handle ships larger than 25 000 DWT and, if the berth is not a permanent structure in the water, the construction of a new permanent structure in the water. In addition, if lands on which the project is to be located are “federal lands” such as under the authority of a Port Authority or similar federal regulated body, a federal Impact Assessment under Section 82 of the IAA may be required. As the Project design and engineering advances, and physical activities better defined, there will be confirmation that they are not deemed Designated Projects and trigger the IAA process. It may also be possible to avoid a federal impact assessment by screening it at the early stages of the IAA process. The requirements for a screening vary depending on the nature of the project.

Table 6.3 – Potential Permits for Proposed Lake Superior Lithium Project – Provincial, Conservation Authority, and Municipal

<table>
<tr><th>Permit</th><th>Applicable Act</th><th>Responsible Agency</th><th>Description</th></tr>
<tr><td>Class Environmental Assessment for Minor Transmission Facilities</td><td>Ontario Environmental Assessment Act</td><td>Ontario Ministry of Environment, Conservation and Parks (MECP)</td><td>For new transformer station; per the Electricity Project Regulation for transformer / transmission station if associated with >115 kV and <500 kV, and <2 km and < 50 km (not associated with power generation).</td></tr>
<tr><td>Work Permit</td><td>Public Lands Act</td><td>Ontario Ministry of Natural Resources (MNR)</td><td>For dredging the dock area assuming it has not been dredged previously or was dredged in the last 5 years</td></tr>
<tr><td>Permit to Take Water (PTTW)</td><td>Ontario Water Resources Act</td><td rowspan="5">Ontario Ministry of Environment, Conservation and Parks (MECP)</td><td>Water taking of more than 50,000 L/day, unless water supply is procured from the municipality. This permit would also be needed to support dewatering & other water management activities</td></tr>
<tr><td rowspan="3">Environmental Compliance Approvals</td><td rowspan="3">Environmental Protection Act</td><td>Industrial Sewage Works including but not limited to residue storage area and process water, runoff and seepage collection, and effluent/water treatment discharging into the environment</td></tr>
<tr><td>Including, but not limited to, air emissions, noise, and vibrations</td></tr>
<tr><td>Hazardous Waste Information Network - will need to register as hazardous waste generator</td></tr>
<tr><td>Species at Risk Overall Benefits Permit</td><td>Endangered Species Act</td><td>Control of activities related to Species at Risk to be fully defined, Note that this permit is dependent on the completion of any Class EAs</td></tr>
<tr><td colspan="4">Lakehead Conservation Authority</td></tr>
</table>

Permit	Applicable Act	Responsible Agency	Description
Prohibited Activities, Exemptions and Permit	*Conservation Authorities Act*, OReg 41/24	Lakehead Region Conservation Authority	Changes to the infrastructure, water crossings, alteration to shorelines and watercourses, and grading within the "regulated lands".
Source Water Protection	*Clean Water Act*, OReg 287/07		Manages the water supply protection areas for the Bare Point Water Treatment Facility. A portion of The Property is within one kilometre of this intake.
Municipal			
Building and Plumbing Permit	Ontario Building Code	Municipality (City of Thunder Bay)	Required for applicable structures.
Demolition Permit	*Planning Act* and Municipal By-laws		Required for applicable structures more than 10 m^2.
Planning Application	*Planning Act* and Municipal By-laws		If rezoning or variance is needed, an application will need to be submitted.
Water service and sewage connection	*Planning Act* and Municipal By-laws		To connect with Municipal water supply and sewage system. Also considers stormwater management.

The applicable requirements under the *Ontario Environmental Assessment Act* will be verified as the Project advances.

The Project may also consider potential changes and upgrades to the existing road access and entrance to accommodate increased and/or changes to traffic. These activities may trigger permit requirements under the:

- *Public Transportation and Highway Improvement Act; Highway Traffic Act*. Ministry of Transportation will need to issue and 'entrance permit; and
- City of Thunder Bay bylaws may require the issuance of a 'driveway permit'.

In the event the Project requires aggregate, it is assumed that it will source material from an existing licensed facility.

The Project may also consider potential changes and upgrades to the existing surface water management network to accommodate changes to stormwater changes and possible discharges. These activities may trigger permit requirements under the:

- *Lakes and Rivers Improvement Act*. Ministry of Natural Resources (MNR) will need to approve any lined impoundments to contain process residue and process water under the 'location approval and plans & specifications approval'.

- City of Thunder Bay bylaws may require approval of changes to the local stormwater management.
- The Lakehead Conservation Authority would need to approve changes to the infrastructure, water crossings, alteration to shorelines and watercourses, and grading within the 'regulated lands'.

6.4 Community

The Lake Superior Lithium Project is located within the City of Thunder Bay located on the traditional territory of Fort William First Nation (FWFN), a community of approximately 964 people in 2021 (Statistics Canada 2023) located about 15 km southwest of The Property. FWFN is a signatory to the Robinson-Superior Treaty and a member of the Nokiiwin Tribal Council Inc., a non-profit organization providing a diverse range of services to the five member First Nations to enhance growth and prosperity in the areas of governance, finance, capacity development, access to justice, economic development, community planning, technical and education services. The Property is also located within the territory of the Métis Nation of Ontario Region 2, and Red Sky Métis Independent Nation.

Avalon recognizes the importance of developing and maintaining strong relationships with Indigenous people advanced through shared values of honesty, respect and open communication. It intends to share project updates with FWFN Chief and Council, and host tours and community engagement sessions.

Aboriginal and treaty rights of Indigenous communities are protected under Section 35 of Canada's *Constitution Act* and the federal and provincial governments share the duty to consult Indigenous communities regarding developments such as this proposed Plant and ancillary infrastructure.

Avalon has initiated preliminary engagement since acquiring The Property in 2023 including meetings and information sharing with FWFN Chief and Council.

Engagement with the local and regional communities will commence and continue as the Project progresses. This will include meeting with the conservation authority, municipal and provincial governments as well as other parties. This consultation will include meetings, public information sessions and other communications to ensure stakeholders are aware of and able to contribute meaningfully to Avalon's proposed activities.

6.5 Decommissioning and Closure

A decommissioning plan outlines how the Project Site land will be rehabilitated to a productive post-closure land use that is physically and chemically stable. Decommissioning plans are developed to meet regulatory requirements and consistent with any traditional land uses and occupancy by

Indigenous communities. These plans should be amended periodically during the life of a Project if material changes are made.

Decommissioning of the Project will require the removal of Avalon's infrastructure that will not be transferred to a third party, as well as the restoration of The Property in accordance with Municipal/Local bylaws for security, physical and chemical stability to support an acceptable land use post closure.

Engagement with local and Indigenous people and communities will occur to be consistent with Avalon social commitments and regulatory requirements in that jurisdiction.

7 FINANCIAL

7.1 Capital Cost Estimate

7.1.1 Purpose

The purpose is to bring the Project definition to the PEA level that supports the development of a capital cost estimate (Capex) with expected accuracy range as defined by AACE for Class 5 estimates. The estimate has an accuracy of -50%+100% based on the information available for the estimate.

7.1.2 Division of Responsibilities

The engineering design and estimating responsibilities were divided between various entities as follows:

- Processing Facilities – Metso
- Non-process infrastructure (NPI) and indirect costs – DRA
- Owner's costs – Avalon

7.1.3 Capex Summary

A high-level summary of the Capex is presented in Table 7.1.

Table 7.1 – High Level Project Capex

CBS	Item Description	Total (CAD$ M)
	DIRECT COST	
1000	Bulk Earthworks	23.7
1500	Detail Earthworks	-
2000	Concrete	36.6
3000	Structural Steel	49.1
4000	Architectural	80.0
4500	Building Services	6.4
5000	Mechanical	327.8
5500	Conveying	8.8
5800	Platework	12.0
5900	Plant Mobile Equipment	2.0
6000	Piping	63.3
6500	Painting & Insulation	5.3
7000	Electrical	47.6

CBS	Item Description	Total (CAD$ M)
8000	Instrumentation & Controls	50.5
	DIRECT COST TOTAL	**713.1**
	INDIRECT COSTS	
9100	Contractor Indirects	71.3
9200	Temporary Services	-
9300	Construction Equipment	-
9400	Temporary Accommodation & Travel	16.4
9500	Capital Spares & Inventory	19.3
9600	External Consultants	39.2
9700	Pre-Commissioning	31.4
9800	Freight & Logistics	40.0
	INDIRECT COST TOTAL	**217.6**
	OWNER'S COSTS	
9900	Owner's Cost (3.5%)	25.0
9901	Operational Readiness (3.5%)	25.0
	OWNER'S COSTS TOTAL	**50.0**
	PROJECT SUB-TOTAL	***980.6***
	UNALLOCATED PROVISION (UAP)	
	Contingency (25% of direct and indirect costs)	232.7
	Escalation	-
	UNALLOCATED PROVISION TOTAL	**232.7**
	PROJECT TOTAL	**1,213.3**

Source: DRA, 2024

7.1.4 Cost Coding

The cost code is a combination of the Area and Work Breakdown Structure (WBS) plus the standard element or commodity codes.

Commodity Code	Description
1000	Bulk Earthworks
1500	Detail Earthworks
2000	Concrete
3000	Structural Steel
4000	Architectural

Commodity Code	Description
4500	Building Mechanical Services
5000	Mechanical Equipment
5500	Conveyor
5800	Platework
6000	Piping
6500	Painting and Insulation
7000	Electrical and Power Supply
7500	Instrumentation/Automation
9100	Contractor Indirect
9200	Temporary Services
9300	Construction Equipment
9400	Construction Camp and Catering
9500	Capital Spares and Inventory
9600	External Consultants (EPCM)
9700	Vendor Rep, Start up and Commissioning
9800	Freight and Logistics
9900	Owner's Cost

Source: DRA, 2024

7.1.5 Estimate Overall Accuracy

The Capex, including contingency, for the Project is prepared to a level 5 of AACE classification (Recommended Practice 18R-97), suitable for the PEA.

The Capex is within the range -50%+100% accuracy at 75%.

7.1.6 Estimate Coordination

Each company involved in developing the estimate provided their completed estimates for full consolidation of the estimate by DRA.

7.1.7 Quantity Development

Quantities are determined based on the Process Mechanical Equipment, Non-Process Mechanical Equipment Lists, and supplemented by estimates or allowances wherever applicable. The following engineering documents are produced:

- Site Plot Plans

- Equipment List
- Basic Process Flow Diagrams
- Layout Drawings

7.1.7.1 Civil and Bulk Earthworks

- Quantities of clearing and grubbing established in square metres from the site plot plans.
- Earthwork estimated using the preliminary MTO provided by engineering.
- No ground water level is assumed to be at the plant site or at any offsite location.
- Piling
- Access roads, site services and deviation of existing above or U/G services
- Allowance for disposal of excess excavated materials offsite is included in the estimate.
- No Engineering MTO's were received from engineering, however allowance for minor demolition works is included in the estimate.

7.1.7.2 Concrete

Quantities are factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

7.1.7.3 Structural Steel

Quantities are factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

The DRA historical quantitative benchmark is used to confirm the factored Structural Steel quantities.

7.1.7.4 Architectural

Building rates $/m^2 is applied and used to populate the estimate.

The list of buildings has been provided by engineering, including the areas for Process and Non-Process building facilities.

7.1.7.5 Building Services:

The cost for Building Services cost is factored as a percentage of the architectural and the major equipment costs based on DRA's historical data and experience.

7.1.7.6 Mechanical Equipment

The mechanical equipment list, indicating size/capacity, and power, along with the process flow diagrams are used to provide mechanical equipment quantities.

An allowance for miscellaneous construction installation materials, such as grout, shims etc. is included in the installation costs.

7.1.7.7 Mechanical (Platework and Tanks)

Plate work weights is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience. The cost of platework and tank is factored separately for Process Facilities and for Non-Process Facilities.

7.1.7.8 Piping

The cost for Process plant piping is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

7.1.7.9 Electrical

The cost for Process Electrical is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

7.1.7.10 Instrumentation and Controls

The cost for Instrumentation and Controls is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

The cost for DCS is factored as a percentage of the mechanical equipment cost for Process Facilities area only.

7.1.7.11 Painting and Insulation

The cost for Painting and Insulation is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

7.1.8 Qualifications and Assumptions

The qualifications and assumptions listed below are considered:

- Quotes from vendors for equipment and materials are valid for budget purposes only.
- It is assumed there is no requirement for mass excavation or imported backfill.

- Suitable backfill material will be available locally. Soil conditions will be adequate for foundation bearing pressures.
- Engineering and construction activities will be conducted in a continuous program with full funding available including contingency.
- Labour productivities are established with input from experienced local contractors and checked against DRA's in-house database of current projects for this area.
- The estimate assumes the construction week is based on 6 days a week and 10 hours per day, single shift 2-weeks on and 2-week off rotation basis. It will be assessed further as the Project advances.
- Bulk materials such as cement, rebar, structural steel and plate, cable, cable tray, and piping are all readily available in the scheduled timeframe.
- Waste provision which accounts for material off-cuts, overlaps, over-excavation, over-pours, over-orders, and minor reworks is inclusive to the estimate rates or factors used.
- Capital equipment is available in the timeframe shown.

7.1.9 Pricing

Most of the pricing is based on in-house information, budgetary pricing obtained namely for major equipment where the balance of pricing is based on in-house information and escalated to the base date. The reporting currency for the estimate is $CAD.

The estimate is priced in Q2 2024 ($CAD) dollars, and future escalation is excluded from this estimate.

The following exchange rates are considered:

Currency Conversion Rates	
Currency	**$ CAD**
Euro	1.48
USD	1.36

Source: DRA, 2024

7.1.9.1 Mechanical Equipment

Offshore supplied equipment is quoted FOB port of embarkation. There is a separate estimate for freight.

Mechanical and electrical equipment are divided into the following categories:

- Major process facility equipment requiring budget quotations (Metso)
- Minor non-process facility equipment requiring budget quotations (DRA)

- Equipment priced from in-house data (DRA)
- Allowances (DRA)
- The erection cost for the mechanical equipment is based on installation labour hours multiplied by the mechanical crew rates.

7.1.9.2 Mechanical (Platework and Tanks)

Prices for mechanical bulks including chutes, ducting and insulation is based on DRA's in-house data and experience.

7.1.9.3 Conveyors

The supply cost of conveyors is based on quoted pricing. The conveyor design, supply and construction cost are included in the estimate.

These rates are populated in the estimate to determine the capital cost.

7.1.10 Manual Labour

The estimate is based on applying unit installation rates against the quantities estimated.

7.1.10.1 Labour Pricing

During the next stage of the Project, a thorough assessment of the local workforce availability in the region will be crucial. It will be necessary to determine if workers from other provinces will need to be recruited to supplement the local labour force.

Currently, labour rates are based on 60-hour work weeks consisting of 10 hours days x 6 days a week (6 x 10). It is assumed all workers are from out of town having to fly-in-fly-out (FIFO) on a two-week on followed by two-week off rotation basis.

Blended composite crew rates are developed for the Mechanical Equipment, Electrical, Instrumentation and controls (EC&I) commodities. The crew rates reflect the price of contracted rates including:

- Contractors' temporary buildings.
- Mobilization / demobilization.
- Training.
- Small tools and consumables.
- Safety supplies.
- Construction equipment.
- Contractor overhead and profit.

Table 7.2 – Crew Hourly Rates

Crew Description	Rev.A	CUR
Civil Works	$223.0	CAD
Concrete Works	$206.0	CAD
Structural Works	$241.0	CAD
Architectural Works	$201.0	CAD
Mechanical Works	$241.0	CAD
Piping Works	$255.0	CAD
Electrical Works	$210.0	CAD
Automation Works	$203.0	CAD
Demolition Works	$270.0	CAD

Source: DRA, 2024

7.1.11 INDIRECT COSTS

7.1.11.1 CONTRACTOR INDIRECT COSTS

Contractor's indirect costs include all contractors' overheads such as contractual requirements (safety, sureties, insurance, etc.), the site establishment and the removal thereof, and company and head office overheads.

The Contractor field indirect also include:

- Construction temporary facilities which include:
  - Offices, mess halls, lunchrooms, bathrooms, first aid, showers, laundry.
  - Warehouses and yards, shelters, etc.
  - Power generation.
  - Aggregate and concrete batch plants.
  - Water systems.
  - Temporary power.
  - Maintenance and clean up.
  - Personnel transportation.
- Temporary services
  - Survey.
  - Inspection.
  - Quality controls.
  - Medical services.

  - Security.
  - Heating.
  - Fuel supply.
  - Fuel stations.
  - Water.
  - Sewage and waste disposal.
  - Third party consultants.
  - Warehousing.
- Construction Equipment
  - Cranes.
  - Vehicles.
  - Mobile equipment.
  - Specialty equipment.

It is important to note that contractor costs to construct the Project are all included in the Direct Costs. Only the costs associated to manage the contract are included in Indirect Costs. Unit prices submitted by contractors are "all-in" rates, which include contractor's construction equipment, operators, insurance, overhead and profit.

7.1.11.2 Spares and Inventory

1. Capital Spares

   Capital Spares for major mechanical equipment is factored by DRA based on in-house data and experience. For minor mechanical equipment, spare parts are 5.1% of equipment purchase price.

2. Operational Spares

   Operational Spares for major mechanical equipment are factored by DRA based on in-house data and experience. For minor mechanical equipment, operational spare parts are 1.3% of equipment purchase price.

3. Commissioning Spares

   Commissioning Spares for major mechanical equipment is factored by DRA based on in-house data and experience. For minor mechanical equipment, critical spare parts are 1% of equipment purchase price.

7.1.11.3 Temporary Accommodation and Travel

An allowance has been provided for accommodation & fly-in/fly-out (FIFO) cost based on in-house information.

7.1.11.4 Project External Consultants

Project external consultants include:

- Consultant engineering.
- Consultant geology.
- Consultant geotechnical.
- Consultant project management.
- Consultant EPCM.
- Consultant construction management.
- Consultant expenses.
- Miscellaneous consultants.
- Vendor representatives.

The requirements for vendor representatives to supervise the installation of equipment or to conduct a checkout of the equipment prior to start-up of the equipment as deemed necessary for equipment performance warranties is calculated and included.

7.1.11.5 Pre-Commissioning

Pre-commissioning includes the cost for a pre-commissioning team required for preparing the Process plant for the commissioning and ramping up of the plant operation.

Pre-commissioning up to wet commissioning, costs in the indirect estimate include:

- Supervision.
- List of packages.
- Preparation of turn over documentation.
- Quality revision.
- Adjustment of equipment, erection, and process specifications.
- Corrections.

The estimate includes the cost of support crews for pre-commissioning among others, including:

- Tools and equipment.
- Safety equipment and services.

- Radios.
- Consumables.
- Transportation, housing, and meals.

Pre-commissioning teams are:

- Start up and commissioning-owner's team.
- Start up and commissioning-EPCM team.
- Start up and commissioning-contractor support.
- Start up and commissioning-vendor support.

All commissioning costs (with material) will be included in the owner's estimate.

7.1.11.6 Freight and Logistics

Freight and Logistics costs were based on calculated in-house information and in all cases, included within the material and equipment costs. In the absence of vendor freight pricing, the following was used for determining freight costs:

- Ocean freight (Europe): The cost for ocean freight including insurance and demurrage cost is factored as a percentage of Overseas mechanical equipment cost based on DRA's historical data and experience.
- Land freight (Europe): The cost for land transport is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.
- Land freight (US): The cost for land transport is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.
- Land freight (Canada): The cost for land transport is factored as a percentage of the mechanical equipment cost based on DRA's historical data and experience.

7.1.12 Owner's Cost

The Owner's Costs is included to this estimate at 3.5% and additionally the Owner's Operational Readiness Cost at 3.5% of Direct Costs.

The Owner's Costs include but are not limited to:

- Land acquisition and rights of way.
- Definition drilling, assaying and related reports and models.
- Owner's project administration team.
- Owner's pre-production.
- Health, safety and security.

- Closure and Rehabilitation.
- Sunk Costs.
- Process rights, royalties, license fees, technology fees and the like.
- Project financing and interest charges.
- Training and recruiting of plant operating personnel.
- Plant operating costs.
- Operating spare parts.
- Sustaining capital.
- Working capital.
- Venture capital.
- Start up and commissioning costs.
- Excess production costs during start-up.
- All costs associated with permits and the like.
- Builder's risk insurance.
- Cost of this or any other study.
- Community relations.
- Emergency response.
- Environmental / permitting / government relations.
- Finance and general administration.
- Human resources.
- Information technology.
- Insurance.
- Legal.
- Logistics.
- Management.
- Power.
- Security.
- Site maintenance and mobile equipment.
- Import Duties.
- Taxes.
- Unrecovered VAT.
- Medical clinic.

- Escalation.

7.1.13 Contingency

Contingency is calculated on a discipline-by-discipline basis, considering items that are quoted, estimated, or factored. Contingency is included to cover items which are consolidated in the scope of work as described in this document, but which cannot be adequately defined at this time due to lack of accurate detailed design information. Contingency also covers uncertainty in the estimated quantities and unit prices for labour, equipment and materials contained within the scope of work.

It should not be considered as compensation for estimating inaccuracy, nor is it intended to cover any costs due to potential scope changes, “Acts of God”, labour strikes, labor disruptions outside the control of the project manager, fluctuations in currency or cost escalation beyond the predicted rates.

The total Contingency of 25% on the direct and indirect capital project costs was established by the project team.

7.1.14 Exclusions

Unless specifically included in the Owner’s Cost, the Capex excludes allowances for the following:

- Escalation during construction.
- Geotechnical information for the site.
- Interest during construction.
- Escalation beyond the base date.
- Schedule delays and associated costs.
- Scope changes.
- Unidentified ground conditions.
- Extraordinary climatic events.
- Any major demolition of existing facilities.
- Modularization.
- Force majeure.
- Labour disputes.
- Insurance, bonding, permits and legal costs.
- Receipt of information beyond the control of EPCM contractors.
- Schedule recovery or acceleration.
- Cost of financing.
- Property taxes, corporate and mining taxes, duties.

- Research and exploration drilling.
- Salvage values.

7.2 Operating Cost Estimate

Opex costs have been estimated at a PEA level. The following sections detail the anticipated operating costs during the operational phase of the Project:

7.2.1 Opex Costs Summary

A summary of the operating costs estimated for the Project can be seen in Table 7.3.

Table 7.3 – Opex Summary

Description	$/ LHM tonne	Cost (CAD$ Million/y)
Operation Personnel	556	16.69
Spodumene Concentrate Purchase	9,131	273.93
Reagents	1,451	43.54
Utilities	589	17.67
Electricity	368	11.03
Consumables (filter cloths, IX resin)	17	0.52
Maintenance	652	19.57
Lab consumable allowance	17	0.50
Byproduct Disposal	210	6.30
LHM Transport Costs	38	1.13
Total	**13,029**	**390.88**

Source: DRA, 2024

7.2.2 Staffing Requirements

The following staff are anticipated for the operation, maintenance and administration of the LiOH plant. The staff are presented alongside the estimated cost per employee in Table 7.4. A total of 128 staff are anticipated to be required for the operation.

Table 7.4 – Staffing Costs

Description	Nr	Base		Fully Burdened	
		$/month	$/a	$/a	$/a
G&A					
HSE Manager	1	13,333	160,000	208,000	208,000
Controller	1	13,333	160,000	208,000	208,000
HR Superintendent	1	13,333	160,000	208,000	208,000
Trainers	2	6,250	75,000	97,500	195,000
Environmental Techs	3	6,250	75,000	97,500	292,500
Community Relations	1	6,250	75,000	97,500	97,500
Safety Officers	2	6,250	75,000	97,500	195,000
Payroll	1	6,250	75,000	97,500	97,500
HR Business Partner	2	7,500	90,000	117,000	234,000
Warehouse Supervisor	1	8,333	100,000	130,000	130,000
Warehouse Tech	4	6,250	75,000	97,500	390,000
Buyer	2	7,500	90,000	117,000	234,000
Logistics	4	7,500	90,000	117,000	468,000
Security Guards	4	5,417	65,000	84,500	338,000
Total G&A	**29**				**3,295,500**
Process Operations					
Plant Manager	1	20,833	250,000	325,000	325,000
Production Manager	1	16,667	200,000	260,000	260,000
Process Superintendent	1	15,417	185,000	240,500	240,500
Admin Assistant	2	6,250	75,000	97,500	195,000
Chief Metallurgist	1	15,417	185,000	240,500	240,500
Met Engineer	2	13,333	160,000	208,000	416,000
Met EIT	2	7,500	90,000	117,000	234,000
Foremen	4	13,333	160,000	208,000	832,000
Lab Technicians	8	6,250	75,000	97,500	780,000
Process Control Tech	2	7,500	90,000	117,000	234,000
Operators	46	7,500	90,000	117,000	5,382,000
Total Process Operations	**70**				**9,139,000**

Description	Nr	Base		Fully Burdened	
		$/month	$/a	$/a	$/a
Maintenance					
Maintenance Superintendent	1	15,417	185,000	240,500	240,500
Engineer Mechanical/EIA	1	13,333	160,000	208,000	208,000
Foremen	2	13,333	160,000	208,000	416,000
Maintenance Planner	2	10,000	120,000	156,000	312,000
Mechanical technicians	8	9,167	110,000	143,000	1,144,000
Electricians / Instrument techs	8	10,000	120,000	156,000	1,248,000
Apprentices (All trades)	7	6,250	75,000	97,500	682,500
Total Maintenance	**29**				**4,251,000**
Total Personnel Costs	**128**				**16,685,500**

Source: DRA, 2024

7.2.3 Feedstock Expenses

The purchasing and transport of the alpha spodumene concentrate to site from operations in the region and abroad is the highest operating cost. A summary of the costs associated with purchasing the feedstock is presented in Table 7.5.

Table 7.5 – Spodumene Purchase and Transport Costs

Spodumene Concentrate	Price, $/t	Consumption t/y	Consumption, t/h	Price, $/y	**$/ LHM t**	**$/ feed t**
Spodumene Concentrate Purchase Price	$ 1,360	196,000	26.13	$ 266,560,000	**$ 8,885**	**$ 1,360**
Spodumene concentrate transport costs	$ 37.62	196,000	26.13	$ 7,373,520	**$ 246**	**$ 38**
Total				$ 273,933,520	**$ 9,131**	**$ 1,398**

Source: DRA, 2024 – transport, Avalon, 2024 – Spodumene price assumption.

7.2.4 Reagents

Reagents consumed in the hydrometallurgical plant and the effluent treatment plant are highlighted in Table 7.6.

Table 7.6 – Reagent Costs

Reagents	Reagent price, $/t	Consumption t/y	Consumption, t/h	Price, $/y	**$/ LHM t**	**$/ feed t**
Sodium carbonate	$ 625.6	40,500	5.40	$ 25,336,800	**$ 845**	**$ 129**
Carbon dioxide	$ 350	3,000	0.40	$ 1,050,000	**$ 35**	**$ 5**
Calcium oxide	$ 360	31,950	4.26	$ 11,502,000	**$ 383**	**$ 59**
Sodium hydroxide (50%)	$ 700	450	0.06	$ 315,000	**$ 11**	**$ 2**
Hydrochloric acid (33%)	$ 600	2,250	0.30	$ 1,350,000	**$ 45**	**$ 7**
H2SO4 (ETP)	$ 204	1,200	0.16	$ 244,800	**$ 8**	**$ 1**
H3PO4 (ETP)	$ 2,550	968	0.13	$ 2,468,400	**$ 82**	**$ 13**
NaOH (ETP)	$ 700	1,777	0.24	$ 1,243,900	**$ 41**	**$ 6**
Carbon dioxide tank rental				$ 30,000	**$ 1**	**$ 0**
Total Reagents				$ 43,540,900	**$ 1,451**	**$ 222**

Source: Metso – Consumption, Vendor - prices

7.2.5 Utilities and Electricity

The natural gas requirements, general utilities and electricity requirements are summarized Table 7.7.

Table 7.7 – Utilities and Electricity Costs

Utilities, Fuel	Utility price, $/m3	Consumption Nm3/y	Consumption, Nm3/h	Price, $/y	$/ LHM t	$/ feed t
Nat gas (Metso Scope)	$ 0.48	14,362,500	1915	$ 6,894,000	$ 230	$ 35
Nat gas (Boiler)	$ 0.48	10,235,569	1365	$ 4,913,073	$ 164	$ 25
Nat gas (ETP Crystallizer)	$ 0.48	-		$ -	$ -	$ -
Nat gas (Rotary Dryer)	$ 0.48	8,655,000	1154	$ 4,154,400	$ 138	$ 21
Nat gas (Heating)	$ 0.48	1,534,803		$ 736,705	$ 25	$ 4
Diesel (1000 litres per day assumed for h	$ 1.50	365		$ 547,500	$ 18	$ 3
Gasoline (100 litres per week per LV assu	$ 1.50	83		$ 124,800	$ 4	$ 1
Total Fuel				$ 17,370,479	$ 579	$ 89
Utilities, water	Utility price, $/t	Consumption t/a	Consumption, t/h	Price, $/y	$/ LHM t	$/ feed t
Sewage Treatment allowance	$ 3.00	50,000		$ 150,000	$ 5	$ 1
Potable water allowance	$ 3.00	50,000		$ 150,000	$ 5	$ 1
Total water				$ 300,000	$ 10	$ 2
Utilities, Electricity	$/kWh	kWh	Consumed power, kW	Price, $/y	$/ LHM t	$/ feed t
Electricity	$ 0.115	95,919,534	12789	$ 11,030,746	$ 368	$ 56
Total Electricity				$ 11,030,746	$ 368	$ 56
Total, Utilities				$ 28,701,225	$ 957	$ 146

Source: Metso and DRA – Consumption, DRA database - prices

7.2.6 Maintenance and Operational Consumables

The maintenance and operational consumables requirements are summarized in Table 7.8. The maintenance costs were estimated by factoring the mechanical equipment cost. In this case, 8% of the mechanical equipment supply cost has been utilized.

Table 7.8 – Maintenance and Operational Consumables Costs

Consumables	Cost, $/y	$/ LHM t	$/ feed t
Filter cloth	$ 429,555.20	14	2.19
IX resin	$ 92,352.00	3	0.47
Total	$ 521,907.20	17	2.66

Maintenance	Cost, $/y	$/ LHM t	$/ feed t
Maintenance material costs, incl. spare parts (8% of MEL CAPEX)	$ 16,673,088	556	85.07
Maintenance (Rotary Dryer)	$ 408,601	14	2.08
Maintenance (Boiler)	$ 223,040	7	1.14
Maintenance (ETP)	$ 984,744	33	5.02
Maintenance (DRA - Other)	$ 1,086,377	36	5.54
Maintenance (Mobile Equipment)	$ 190,672	6	0.97
Total	$ 19,566,521	652	99.83

	Cost, $/y	$/ LHM t	$/ feed t
Lab Consumables allowance	$ 500,000	17	2.55

Source: Metso – Plant Consumables, DRA, 2024 – Maintenance costs and lab consumables

7.2.7 By-Product Transport and Disposal Fees

With limited capacity on The Property for storage and disposal of the analcime byproduct and effluent treatment crystallized salt waste, these materials must be shipped offsite and disposed of elsewhere. The costs associated with this transport and disposal can be seen in Table 7.9.

Table 7.9 – By-Product Transport and Disposal Costs

Byproduct Disposal		Price, $/t	Consumption t/y	Consumption, t/h	Price, $/y	$/ LHM t	$/ feed t
Analcime transport costs		$ 19.6	277,500	37	$ 5,437,266	$ 181	$ 28
Analcime disposal costs		$ -	277,500	37	$ -	$ -	$ -
ETP Sludge Disposal Fee		$ 147.0	5,055	0.67	$ 743,085	$ 25	$ 4
ETP Sludge transport Fee		$ 24.5	5,055	0.67	$ 123,848	$ 4	$ 1
Total					$ 6,304,198	$ 210	$ 32

Source: DRA, 2024, Vendor quote for sludge disposal

7.2.8 Lithium Hydroxide Transportation

The costs associated with transporting the LiOH product from the plant to the battery plants in southern Ontario are estimated and presented in Table 7.10.

Table 7.10 – Lithium Hydroxide Transportation Costs

Lithium Hydroxide Transport Costs		Price, $/t	Consumption t/y	Consumption, t/h	Price, $/y	$/ LHM t	$/ feed t
Lithium Hydroxide Transport Costs		$ 37.62	30000		$ 1,128,600	$ 38	$ 6

Source: DRA, 2024

7.3 Financial Analysis

The economic analysis of the Project is preliminary in nature and is based on several assumptions owing to the early stage of the Study. As a result, there is no certainty that the 2024 PEA will be realized.

The economic analysis is based on the discounted cash flow (DCF) method on a pre-tax and after-tax basis at a discount rate of 8% with mid-year discounting. For the purposes of the evaluation, it is assumed that the operations are established within a single corporate entity. The Project has been evaluated on an unlevered, all-equity basis.

Cash inflows for the analysis consist of annual revenue projections over the life of the project based on the estimated LHM production. Cash outflows consist primarily of Capex and Opex expenditures for the plant, as well as income taxes paid. Cash outflows are subtracted from inflows to arrive at projections of the annual cash flow on both a pre-tax and after-tax basis. Sensitivity analyses are carried out to determine the impact of key project parameters, such as product prices, Capex, and Opex on the project economics.

The production schedule used in this analysis is based on the Production Plan outlined in Section 8.9. The capital and operating costs are taken from the estimates detailed in Sections 7.1 and 7.2.

All costs and pricing are in Q3 2024 Canadian dollars. No provision is made for the effects of inflation in this analysis.

All dollar values provided in this section are in Canadian Dollars unless otherwise stated.

7.3.1 Forward Looking Information

The results of the economic analyses discussed in this section represent forward-looking information. The results depend on inputs that are subject to known and unknown risks, uncertainties, and other factors that may cause actual results to differ materially from those presented here. Forward-looking information includes assumptions and estimations of:

- Price of LHM and spodumene concentrate;
- Foreign exchange rates;
- Proposed chemical plant production plan;
- Recovery rates of lithium in the chemical plant;
- Product purity achieved in the chemical plant;
- Ability of plant, equipment, processes to operate as anticipated;
- Sustaining and operating costs;
- Environmental, social, and licensing risks;
- Taxation policy and tax rate, including application of Investment Tax Credits (ITCs);
- Royalty agreements;
- Cost inflation;
- Ability to maintain social license to operate;
- Unrecognized environmental risks;
- Closure costs; and
- Unforeseen reclamation expenses.

7.3.2 Modelling Assumptions

Given the early-stage nature of the Study, various assumptions have been made in this analysis to arrive at the financial metrics of the Project.

The key pricing and revenue assumptions include:

- Revenue is derived solely from the sale of LHM;
- All product is sold in the year it is produced;

- A long-term LHM price of USD$26,000/tonne, as provided by Avalon based on an average price from recent benchmark studies for similar projects and forecasts from investment institutions;
- A long-term spodumene concentrate price of USD$1,000/tonne, as provided by Avalon;
- A flat, long-term exchange rate of 1.36 Canadian Dollars to 1.00 US Dollar;
- No selling costs associated with the product outside of freight costs;
- Product losses in transport of 0.05% by weight;

The key operating and capital expenditure assumptions include:

- Plant operating life of 30 years;
- Development capital spending commences with procurement in 2027 (FY-2) and concludes in 2029 (FY1) with the completion of the second line. Development Capex is split 15%/40%/45% between FY-2/FY-1/FY1, as specified by Avalon;
- Sustaining capital costs of $2M for each year the plant is operating;
- Closure capital costs of $40M. For the purpose of the PEA; closure capital is spent in a single year immediately after the conclusion of plant operations;
- Capital costs funded 100% with equity (no debt or financing costs considered);
- The depreciable portion of the Development Capex is estimated to be 88.4% with the remainder expensed. The expensed portion includes Temporary Accommodation and Travel, Pre-Commissioning costs, Freight and Logistics costs, Operational Readiness costs complete with associated contingency. The same proportion is used for Sustaining Capital.

No royalties are applicable to the Project. No information is available on any potential Impact Benefit Agreements (IBAs) in favour of local indigenous communities and these have been excluded from the analysis.

The post-tax analysis includes the following aspects of Federal (Canadian) and Provincial (Ontario) income tax codes:

- Federal income tax rate of 15% and provincial income tax rate of 10%. The provincial income tax rate includes a deduction of 1.5% from the general rate of 11.5% for the Manufacturing and Processing Tax Credit;
- Net Operating Losses can be carried forward for up to 20 years;
- The entire depreciable portion of the Development Capex is included in a single Capital Cost Allowance (CCA) pool for simplicity. The CCA rate used is 25%;
- The plant is considered ‘available for use’ for CCA purposes on start-up, including the ramp-up period, as indicated by Avalon;

- The Project is eligible for the Canada Clean Technology Manufacturing ITC. This credit is applied as a 30% refund of depreciable Development Capital received as pre-tax cash flow in the year following the capital expenditure.

7.3.3 FINANCIAL SUMMARY

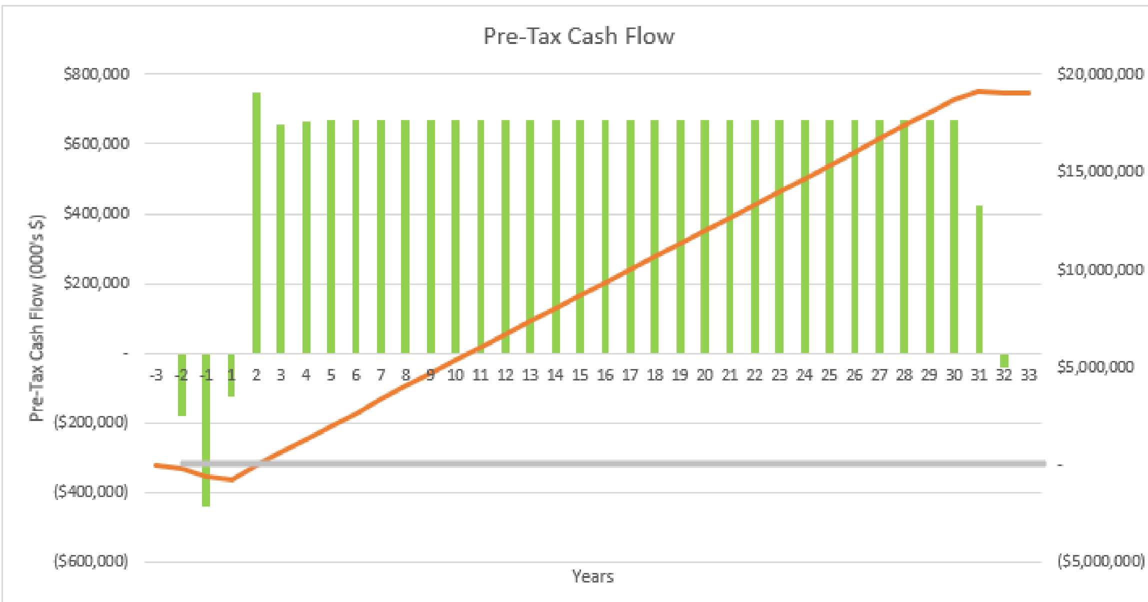
A summary of the key financial metrics of the Project is provided in Table 7.11. Charts of the pre-tax and after-tax cash flows per year are provided in Figures 8.0 and 9.0. A summary of the cash flows is provided in Appendix F.

Table 7.11 – Summary of Key Financial Metrics

Parameter	Unit	LOP Total / Average
General		
LHM Price	USD/tonne	26,000
Spodumene Concentrate Price	USD/tonne	1,000
Project Operating Life	years	30
Production		
Spodumene Concentrate Feedstock Grade	% Li_2O	6.0
Feedstock Processed (LOP)	Mt	5.9
Number of Processing Lines		2
Feedstock Processing Rate per Line	kt/year	98
Total Feedstock Processing Rate	kt/year	196
Lithium Recovery	%	89.1
Product Purity – LHM	%	98.0
Product Tonnage (LOP)	Mt	0.9
Product Tonnage (LCE) (LOP)	Mt	0.8
Capex		
Development Capital	$M	1,213
Clean Technology Manufacturing ITC (LOP)	$M	(322)
Sustaining Capital (LOP)	$M	62
Closure Capital	$M	40
Revenue and Costs – Steady State		
Steady State Revenue per Tonne of Product	$/t	35,360
Feedstock Cost (Delivered) per Tonne of Product	$/t	9,131
Operating Cost (Excluding Feedstock) per Tonne of Product	$/t	3,898
Total Operating Cost per Tonne of Product	$/t	13,029

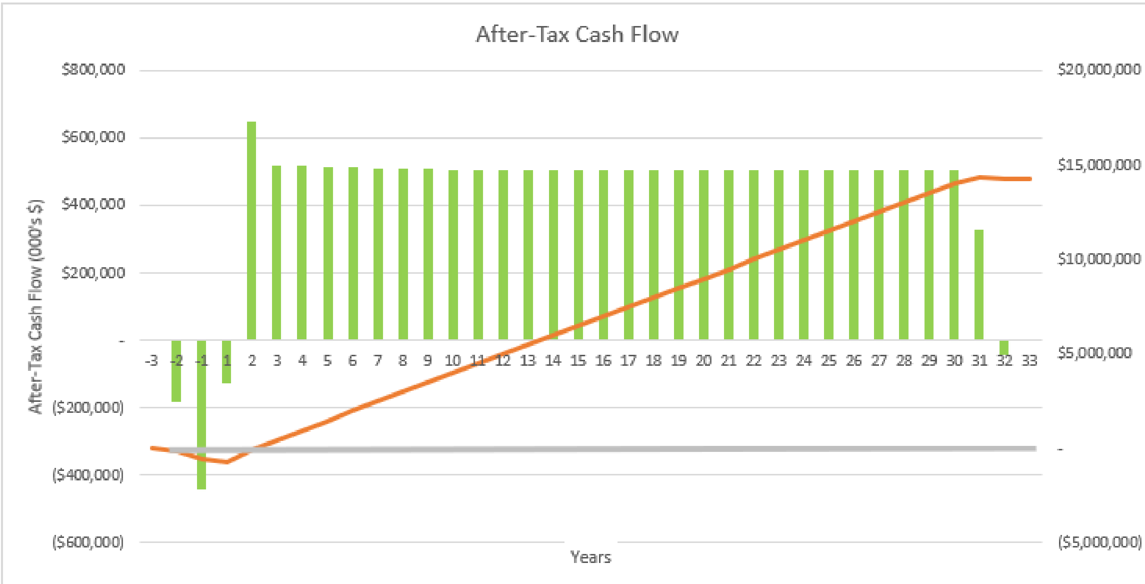
Parameter	Unit	LOP Total / Average
Taxation		
Income Tax – Federal and Provincial (LOP)	$M	4,776
Cash Flow		
Operating Earnings (LOP)	$M	20,052
Free Cash Flow – Pre-Tax (LOP)	$M	19,059
Free Cash Flow – After-Tax (LOP)	$M	14,283

Figure 7-1 – Pre-Tax Cash Flow per Year



Source: DRA, 2024

Figure 7-2 – After-Tax Cash Flow per Year



Source: DRA, 2024

7.3.4 Economic Analysis Results

The results of the economic analysis are presented in Table 7.12 on both a pre-tax and after-tax basis.

It should be noted that this analysis is preliminary in nature given the early-stage nature of the Study and relies on several assumptions. There is no certainty that the economic assessment presented will be realised.

Table 7.12 – Economic Analysis Results

Parameter	Units	Pre-Tax	After-Tax
Net Revenue (LOP)	$M	31,888	31,888
Free Cash Flow (LOP)	$M	19,059	14,283
NPV @ 8% discount rate	$M	5,559	4,119
IRR	%	55.5	47.5
Discounted Payback period	years	2.2	2.5

7.3.5 Sensitivity Analysis

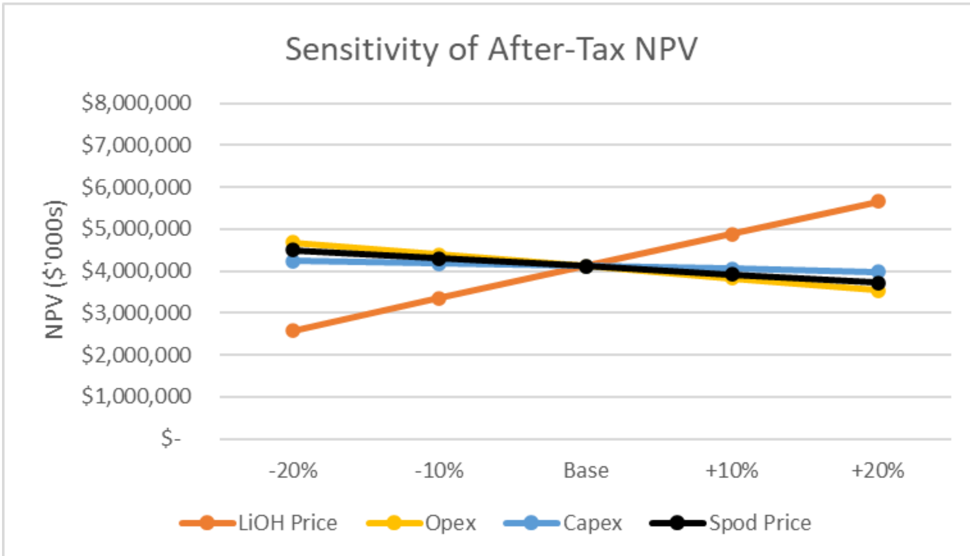
Sensitivity analyses were carried out to assess the impact of changes in product price, feedstock price, Development Capex, and overall Opex on the Project's NPV at an 8% discount rate, IRR, and payback period. This analysis was carried out on an after-tax basis.

The impact of each variable was examined individually with an interval of ±20% and increments of 10% applied. The Project after-tax economic performance is most sensitive to product price, while the sensitivity to Capex, Opex, and feedstock price is similar. As the Opex is dominated by the cost of feedstock purchase, the sensitivity of the Project economics to the two are similar with the sensitivity to the overall Opex being slightly higher. The results of the sensitivity analysis of the Lake Superior Lithium Project in terms of NPV, IRR and payback period are summarised in Table 7.13, Figures 7.3, 7.4 and 7.5

Table 7.13 – After-Tax Economic Analysis Sensitivity Tables

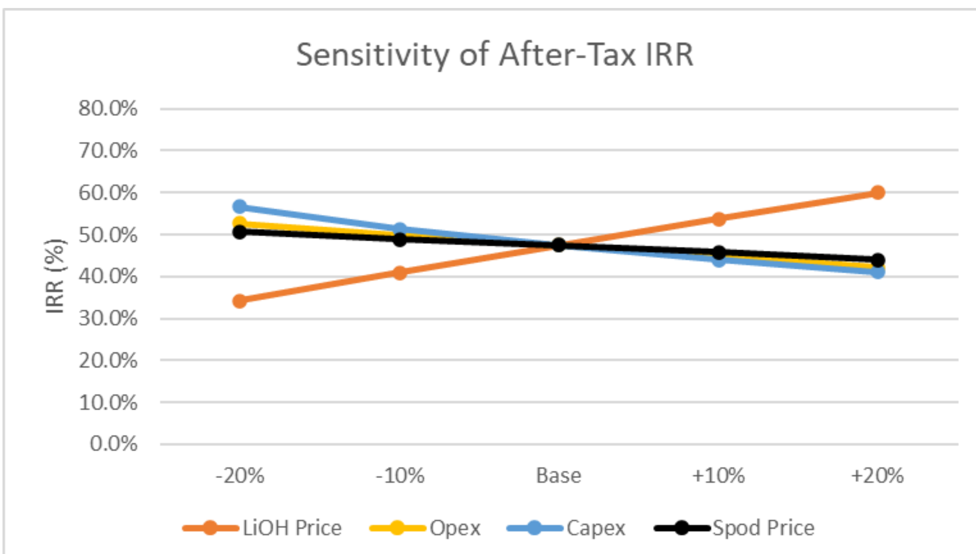
LiOH Price	**Units**	**-20%**	**-10%**	**Base**	**+10%**	**+20%**
NPV @ 8.0%	$ Billion	$2,583	$3,351	$4,119	$4,880	$5,655
IRR	%	34.2%	41.0%	47.5%	53.7%	60.1%
Payback	Years	3.5	2.9	2.5	2.2	2.0
Opex	**Units**	**-20%**	**-10%**	**Base**	**+10%**	**+20%**
NPV @ 8.0%	$ Billion	$4,690	$4,395	$4,119	$3,830	$3,541
IRR	%	52.6%	49.8%	47.5%	44.9%	42.2%
Payback	Years	2.2	2.4	2.5	2.6	2.8
Capex	**Units**	**-20%**	**-10%**	**Base**	**+10%**	**+20%**
NPV @ 8.0%	$ Billion	$4,249	$4,174	$4,119	$4,053	$3,986
IRR	%	56.6%	51.4%	47.5%	44.0%	41.0%
Payback	Years	2.1	2.3	2.5	2.7	2.9
Spod Price	**Units**	**-20%**	**-10%**	**Base**	**+10%**	**+20%**
NPV @ 8.0%	$ Billion	$4,499	$4,299	$4,119	$3,924	$3,729
IRR	%	50.7%	48.9%	47.5%	45.8%	44.0%
Payback	Years	2.3	2.4	2.5	2.6	2.7

Figure 7-3 – Sensitivity of the Project After-Tax NPV to Product Price, Feedstock Price, Capex and Opex



Source: DRA, 2024

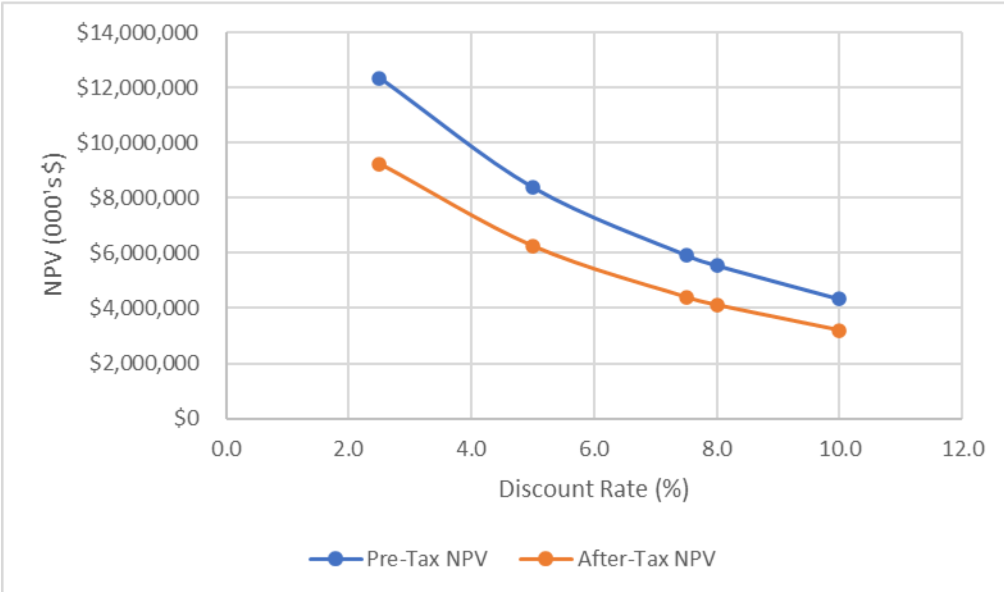
Figure 7-4 – Sensitivity of the Project After-Tax IRR to Product Price, Feedstock Price, Capex and Opex



Source: DRA, 2024

Figure 7-5 presents the variation in pre-tax and after-tax NPV at discount rates ranging from 2.5% to 10.0%, including the selected discount rate of 8.0%. This analysis uses base case values of product price, feedstock price, Capex and Opex.

Figure 7-5 – Project Pre-Tax and After-Tax NPV at Different Discount Rates



Source: DRA, 2024

8 PROJECT EXECUTION PLAN

8.1 Objectives

This section outlines the proposed philosophy and approach to executing the Lake Superior Lithium Project through to production, assuming that DRA is engaged to do so. Following the completion of this PEA and the subsequent feasibility study (the Feasibility Study) and after approval is received to proceed with this project, a Project Definition phase is required to finalize the design criteria, produce a control estimate for project execution, and define the operating costs more accurately. Steps will be taken during this Project Definition phase to reduce the risks and pursue opportunities which are identified in the Feasibility Study.

The Project will involve:

- Design, engineering, procurement and construction of the new LHM production plant and the associated material handling and infrastructure items.
- commissioning and operation in line with the agreed execution schedule.

In terms of project management, the Project requires that:

- Safety and environmental requirements, both statutory and otherwise, are fully satisfied throughout all project phases.
- First Nations community engagement takes place regularly before construction and as the project progresses into operations and beyond.
- The completed facilities and associated infrastructure:
  - Comply with design and engineering specifications,
  - are completed and commissioned in accordance with a plan and to suit feed requirements,
  - are completed and commissioned within the approved budgets.
  - Operational organization is established in accordance with a plan consistent with the commissioning and operational needs of the site,
  - Operational organization is established within the approved budget, and
  - Overall project cost is consistent with the established estimate of capital expenditure.

8.2 Execution Methodology

8.2.1 General

The project will be implemented using either an EPC or an EPCM approach, at Avalon's preference. A detailed engineering estimate will be prepared as a component of the overall project capital cost estimate. If Avalon selects an EPC approach, the engineering estimate would be subject to an additional "Fixing Fee" (typically 7 to 10% of direct and indirect costs) to consider the various additional risks which would be transferred to the Contractor.

Detailed engineering will immediately follow the Front-End Engineering Design (FEED) phase. The principal deliverables following the FEED phase, for which a duration of eight weeks is allocated, are frozen process design and plant general arrangements. A detailed schedule for engineering, procurement and construction will also be finalized at that time which will be used to control progress of project activities.

8.2.2 Integrated Team

Effective team building and alignment will be implemented to ensure that the integrated Avalon-DRA team is aligned to a common purpose and understands the project's goals and objectives.

It is envisaged that an Avalon representative will be resident in DRA's offices during the detailed engineering and procurement phases of the work. Other project work will be carried out from site and from satellite offices (e.g. sub-consultants) as required and appropriate. As the project activities move towards construction, members of the office team will move to the project site.

8.2.3 Management

Overall management of the project will be conducted by DRA. The management of all contractors and consultants involved in the design and engineering, procurement, construction management and pre-commissioning of the new plant facilities will be by DRA. DRA will report to Avalon's designated Project Manager, who in turn will report to (and get direction from) Avalon's stakeholder members.

Personnel appointed to the management teams will have the appropriate qualifications and experience for the positions they occupy.

8.2.4 Project Organization

The project organization consists of the following major organizational groups:

- Avalon Advanced Materials Inc. — Owner
- DRA — Main EPC/EPCM Contractor
- Consultant — Geotechnical Sub-contractor
- Consultant — Construction Management Sub-contractor

8.2.5 Project Structure, Relationships, Roles and Responsibilities

The organizational and communications protocols will be defined during the development of the Feasibility Study, which will continue into the execution phase of the project, are as follows:

- Executive interrelationship between DRA and Avalon.

- Avalon project team organization, including both corporate and Thunder Bay-based site teams.
- DRA project management, including direction of and interaction between Process Engineering, Discipline Engineering, Drawing Office, Specialist Services, Procurement, Project Controls, Construction, and Commissioning groups.
- Individual DRA structures for the groups mentioned above.

8.2.6 Engineering, Procurement, and Construction

DRA services on the project will cover project management, engineering, procurement, construction management and commissioning, as well as assistance as required with process optimization. These services will include management and coordination of various other service providers and vendors.

Project direction will be provided by a management group, consisting of an overall Project Manager for the plant and associated infrastructure, who is supported by a Project Engineer, a Project Services Manager, and Construction and Commissioning Managers.

The role of Project Manager is to manage, co-ordinate and rationalize work performed by all project team members. They will ensure, where applicable, that maximum benefits are derived from engineering, designing, and construction of the project, and that progress of the work is as per the implementation program. They will have day-to-day responsibility for coordination and management of the project as a whole.

The Project Manager will focus on control of their scope of work, budget and schedule. After transfer to the field they will also be accountable for maintaining occupational health, safety, environmental and quality standards. The Construction Manager will, however, take overall responsibility on site for these aspects.

The Project Engineer(s) and Discipline Leads will broadly undertake the following:

- internal coordination of tasks within each discipline;
- internal coordination of the dedicated multidisciplinary DRA engineering team;
- external coordination with Avalon, vendors and the site;
- signing off engineering regarding the achievement of process intent;
- management of services budgets by discipline;
- active control of scope, schedule and budget;
- active implementation of the change management process;
- preparation and issuance of engineering deliverables and technical integrity thereof; and
- reporting to Project Manager on achievement of objectives and resource requirements.

DRA, as EPC/EPCM Contractor will be responsible for coordinating the integration and / or interfacing of the various process, metallurgical and related technologies.

8.2.7 Temporary Facilities

Early in the Execution phase a study will be carried out to investigate existing on-site office facilities as required for the construction phase. It is assumed that Avalon will provide areas for contractors to erect site offices, trailers, storage, and washroom facilities as required. Power and water hook-ups as well as sewage connection points will be provided to each contractor by Avalon.

It is envisaged that the communications system for the construction period will be part of Avalon's permanent communications system. It will provide for adequate telephone and internet services for Avalon, DRA, and construction contractors.

It is assumed that electrical power for construction is available at the existing Avalon site.

The water treatment plant for wastewater collected from the construction management and contractor offices must meet the demand of the peak work force. The existing water treatment facilities at the site are anticipated to be sufficient and readily available for this project.

8.2.8 Accommodation

Available accommodation in the area of the plant will be studied early in execution for its sufficiency and suitability to accommodate project personnel visiting the site during construction, including members of DRA's team as well as Vendor representatives. It is expected that existing accommodations in the region will be sufficient.

There is currently no plan to construct a camp to house construction workers. It is assumed that construction contractors will accommodate their work force in the local region. In developing construction labour rates, an allowance will be made for meals and local accommodation.

8.2.9 Interface and Interaction Profile – Owner / Engineer

Avalon's team, including team members from the Thunder Bay operation, will have varying responsibilities and subsequent interactions with the DRA project team.

The Avalon team will perform ongoing review and approval functions which will have a direct bearing on the progress of the project. To avoid having these functions impede project progress, the designated Avalon team members will need to be available when required either at the DRA project office or remotely as agreed at the outset of the project.

Although Avalon team members report directly to the Avalon's project manager, they are still expected to align themselves with DRA's internal project procedures and review cycles. Included in this category are the functions covering review and approval of designs, layouts, drawings and specifications for all disciplines.

8.3 Value Adding Strategies

While it is recognized that individual savings obtained by specific strategies are not additive due to overlap of common features, a combination of strategies can result in substantial savings and added value. These will be systematically reviewed during the Feasibility Study.

8.3.1 Front End Engineering Design (FEED) Practices

The effects on cost and schedule from implementing FEED practices are significant and benefits result from its implementation. A FEED strategy will be developed during the Feasibility Study.

8.3.2 Value Engineering

The most effective use of Value Engineering is to perform specific, well structured, clearly defined design studies to establish the full extent of potential improvements to the overall value of the project. Value Engineering studies will be conducted early in the execution phase to resolve any outstanding design issues and opportunities.

8.3.3 Constructability

Constructability is the integration of engineering, construction and operations knowledge and experience during the planning and design process to optimize overall project objectives. Utilizing proven constructability ideas, Lead Engineers will solicit ideas that contribute project benefits in terms of savings in cost and time, construction simplification, operating safety, and project quality. Recently completed projects have achieved significant schedule and cost improvements due to this process.

8.3.4 Zero Harm / People Based Safety

A people-based safety approach will be implemented to identify and prevent unsafe actions and conditions. This process involves training and facilitating supervisors in promoting a positive approach through reinforcement and recognition of safe work practices. It also examines “root causes” of events, which may contribute to unsafe behavior. This approach is a single process with a dual focus (one on supervision and one on employees) which identifies, tracks and corrects unsafe work practices before they result in injury.

8.3.5 Integrated Commissioning and Start-Up

Proper planning of all activities well in advance of the actual commencement of individual activities in the field will be essential to the achievement of plant completion within schedule.

The Commissioning Manager will be responsible for all commissioning and start-up activities, excluding those activities that must be performed by construction to achieve mechanical completion of the project. The Commissioning Manager, in conjunction with the Project Manager will develop pre-commissioning, commissioning and start-up schedules in line with actual project execution.

These schedules will then be integrated with the project schedule. The mechanical completion and commissioning requirements will be aligned to Avalon requirements and each phase has been defined to ensure compliance to specific requirements and to identify the accountable and responsible parties at each phase.

8.4 Project Controls

The purpose of project controls activities is to provide concise, timely and accurate reporting to the team and other key stakeholders. A Project Controls Plan will be finalized in the Feasibility Study.

8.4.1 Overall Progress and Cost Control Methodology

Good planning is a prerequisite of effective project control. The foundation of progress monitoring and cost control methods will be in accordance with the agreed and realistic baseline scope, plan and budget of the Feasibility Study, which will be measured against agreed criteria. Control measures will focus on achieving the goals of the project, without being distracted by artificial targets.

8.4.2 Signing off Project Baseline Plan and Budget

A robust project schedule will be further developed in collaboration with the Owner's team, building on the preliminary schedule developed for this PEA.

8.4.3 Change Management

The management of changes to minimize impact on the project cost and schedule will be the responsibility of the entire Project Team under the direction of the Project Manager. Detection, assessment and management of these changes will be implemented through the various change management systems. The change management program will be developed during the Feasibility Study.

8.4.4 Control of Costs

Real time cost data provides an essential tool for decision making to control costs. The budget figures will be input at activity level, providing the basis for achieving effective cost control.

All parties will be involved as early as practical in making sure that the design / construction / operation / maintenance needs are satisfied and to minimize impacts of any changes.

8.4.5 Document Control

Document Management will be the focal point for all matters relating to the receipt, capture, tracking, recording, distribution and dispatch of project documentation and drawings. Document Control will be set up in accordance with the DRA document control procedures, and documents will be posted using SharePoint.

8.5 Procurement and Contracts

8.5.1 Procurement

Procurement, quality surveillance, and expediting activities will be performed by the Engineer with input and assistance as required from Avalon, and with all purchases made by DRA. All major equipment purchase orders will be placed on a priority basis, to ensure the timely flow of vendor data in support of the engineering process, with deferral of associated equipment procurement, manufacture and delivery phases until required to support the construction schedule.

DRA will prepare enquiry packages, adjudications and placement of orders. The Project Engineer will ensure that procurement procedures are adhered to when issuing enquiries, purchase orders or contracts.

Table 8.1 shows the anticipated procurement packages and services sub-contracts which are currently foreseen for the project.

Table 8.1 – Procurement Packages Expected for Execution Phase

Package	Title	Type
1	PM Consulting and Construction Management	Services Contract
2	SPP (Steel, Platework, Piping) – Fabrication	Material Supply
3	SPP (Steel, Platework, Piping) – Installation	Services Contract
4	Pyrometallurgical package (Calciner / cooler)	Equipment Supply
5	Grinding Package	Equipment Supply
6	Pressure Leaching and Auxiliaries Package	Equipment Supply
7	Filtration Systems	Equipment Supply
8	Conversion and Auxiliaries Package	Equipment Supply
9	Ion Exchange and Auxiliaries Package	Equipment Supply
10	Carbonation Circuit Package	Equipment Supply
11	Crystallization package	Equipment Supply
12	Drying and Packaging Package	Equipment Supply
13	Reagent Systems	Equipment Supply
14	Cooling Water Package	Equipment Supply

Package	Title	Type
15	HP Steam Boiler Package	Equipment Supply
16	Rotary Dryer (Analcime) Package	Equipment Supply
17	Effluent Treatment Package	Equipment Supply
18	Tank Supply and Erection	Equipment Supply
19	Demineralized Water Treatment Skid	Equipment Supply
20	Pumps	Equipment Supply
21	Belt Conveyors	Equipment Supply
22	Vibrating Feeders	Equipment Supply
23	Electrical and Instrumentation Installation	Services Contract
24	Instrumentation	Equipment Supply
25	Civil and Concrete Installation	Services Contract
26	Samplers	Equipment Supply
27	MCCs	Equipment Supply
28	Control System	Equipment Supply
29	Structural Design Service (Architect)	Services Contract
30	Air Compressors	Equipment Supply
31	Overhead Cranes	Equipment Supply
32	Safety Shower System	Equipment Supply
33	Mobile Equipment	Equipment Supply
34	Light Vehicle fleet	Equipment Supply
35	Train Cars	Equipment Supply
36	Metallurgical Laboratory	Supply and install
37	Modular Buildings	Supply and install
38	Process Winter Buildings	Supply and install
39	Feed Storage Building	Supply and install
40	Deep Water Port Refurbishment	Services Contract
41	Demolition (Admin and historic foundations)	Services Contract
42	Geotechnical Investigation	Services Contract

8.5.2 Construction Contracts

Construction contracts will be awarded for the supply and installation of various commodities and purchase orders for most of the equipment. The anticipated contracts for the project are as follows:

- EPCM Contract

- Civil Installation (Earthworks and Concrete) Contract
- Steel, Piping and Platework (SPP) Supply Contract
- Steel, Mechanical, Piping and Plate Work (SMPP) Installation Contract
- Electrical Contract

8.5.3 Logistics

The primary responsibilities will include the control of access to site, the control of material deliveries to the correct construction area, construction waste removal and the import of borrow material.

8.6 Design and Engineering

Discipline engineers will be responsible for providing the following services for each of the project areas:

- Mechanical
- Piping
- Electrical
- Instrumentation
- Process
- Civil
- Structural

8.6.1 Key Objectives

Key objectives of the design work will include:

- Design will provide no margin over specifications unless specifically requested by Avalon.
- Design will be always based on safety and health of personnel and safe condition of plant and equipment under all foreseeable conditions and including start up, operation, shutdown and maintenance.
- Design will meet all required local, Ontario health and safety requirements.
- New facilities will be suitably designed for the cold weather climate of northwestern Ontario.
- Particular focus will be placed on facilitation of maintenance and clean up in plant design.
- Materials and equipment will be selected to minimize number of manufacturers and types of equipment wherever possible, aiming to minimize plant installed cost and spare parts inventory.
- Design will take into consideration consequences of non-performance of installed equipment and make appropriate provision in terms of safety, environmental and economic aspects.

- Layout of facilities and arrangement of equipment will provide adequate accessibility for safety, operation and maintenance, including use of mobile maintenance equipment where appropriate. Accessibility will be verified with the aid of 3D modeling.
- Drawings and calculations will be certified by appropriately qualified professional engineers. A common architectural approach to design of buildings and other facilities will be applied.

Concepts / documentation to be further developed include:

- Engineering design criteria.
- Engineering design and workflows.
- Engineering progress.
- 3D model progress.
- Engineering procedures.
- Decision / holds registers.
- Engineering tools.
- Engineering reviews.
- Computer aided design and drafting.
- Engineering quality and approvals.
- Hazard and operability (HAZOP) reviews.

8.7 Construction

8.7.1 Safety Fundamentals

The vision for safety is "Beyond Zero". Safety must be a shared value that project success goes beyond delivering projects on schedule and within budgetary expectations. The objective is to always conduct all project aspects safely by minimizing all identified risks without compromise, based on a combination of legislative measures and using a people-based safety system.

A well-defined set of safety rules and fundamentals will be strictly enforced to ensure safety of all stakeholders involved with the Project.

8.7.2 General Appointments

A Construction Manager will be responsible to the Project Manager for all site construction activities.

Construction teams will be organized to ensure they are adequately supervised such that project schedule, cost and quality control criteria are met. Construction work will be carried out by competent contractors with proven experience of work in similar environments of a similar scale.

The overall co-ordination of construction will be by the Construction Manager, who will not itself directly undertake construction.

Construction will be carried out in accordance with local legislation and approved procedures.

All free issue materials and equipment for incorporation in the works will be received, stored and issued under the guidance of the Construction Manager.

The Owner in discussion with the Construction Manager will arrange for the supply of utilities and services (electricity, potable water, telephones, etc.) by the relevant authorities at connection points convenient for off take by the contractors. The Construction Manager will monitor proper installation and use of these utilities and services by contractors.

8.7.3 Site Management

The appointed Construction Manager will report to the Project Manager. The Construction Manager will have responsibility for all site construction activity, as well as for control of all free issue materials, safety, security, and industrial relations. The Construction Manager may also appoint other personnel as necessary, such as: civil, structural, mechanical, piping, electrical and instrumentation supervisors, construction planner(s), safety and administration personnel, materials controller, document controller(s), contract administrator(s) and quantity surveying services.

8.7.4 Material Control and Warehousing

Material logistics on site will be the responsibility of the Construction Manager. Responsibilities in this capacity include: management of receipt, storage and issue of free issue equipment, management of lay down yard and warehouse, and site expediting as required.

8.7.5 Public Relations and Community Liaison Management

Public Relations and Community Liaison will only be through Avalon's team.

8.7.6 Site Accommodation

Accommodations near the site will be established in consultation between DRA and Avalon. Tendering contractors will be required to indicate their anticipated accommodation requirements with their tender submissions. Such requirements will be re-confirmed by the successful contractor at time of contract award, and subsequently at monthly intervals.

8.8 Commissioning

The standard DRA commissioning procedure forms the basis of the project schedule at this stage. A final commissioning procedure will be developed and submitted for approval during Execution.

Plant start-up is a demanding and complex phase of the project. It involves the combined effort and co-operation of all parties, Avalon's operations and commissioning teams, contractors and vendors. A Commissioning Manager will be appointed with overall responsibility for commissioning and handover to Avalon.

The Commissioning Team will be based at the site office. Mobilization of this team will occur during the final weeks of construction and will include key personnel from the detailed engineering phase.

8.8.1 Commissioning Safety

Maintaining the required safety conditions during plant commissioning and start-up is a demanding task. Overlap with construction, inherent risks of testing equipment and operator unfamiliarity with new systems are all complicating factors. For this reason, the adherence to proper safety precautions must take a primary role. The operation of equipment in hazardous conditions is not permitted.

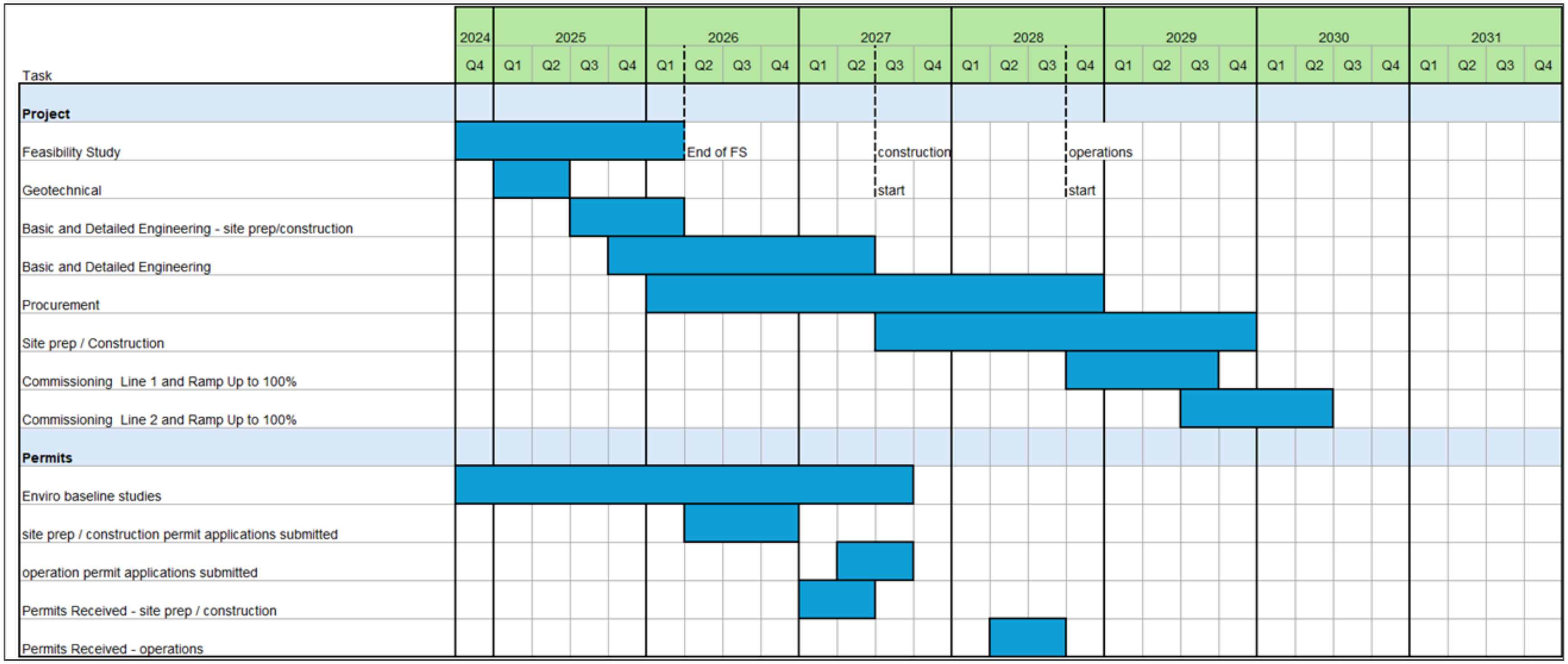
8.8.2 Ramp Up and Handover

Handover will be deemed complete on successful operation of the plant at name plate capacity as defined in the Contract. The test will be deemed complete if any delays were caused by a lack of operational support or lack of material for processing beyond the reasonable control of the EPC/EPCM Contractor.

8.9 Schedule

A high-level project schedule can be seen in Figure 8-1.

Figure 8-1 – High Level Project Schedule



Source: Avalon, SLR and DRA, 2024

The schedule is considered aggressive but achievable if all required permits can be granted in the timeframes advised by the government regulators. To maintain the illustrated schedule, the Feasibility Study should kick-off in Q4 of 2024. The Feasibility Study will inform the permit applications. In addition to the Feasibility Study, baseline environmental work must start in 2024 and a geotechnical investigation will need to be completed in the summer of 2025 to allow for timely permit application submittal.

Procurement of long lead items is anticipated to begin in early 2026.

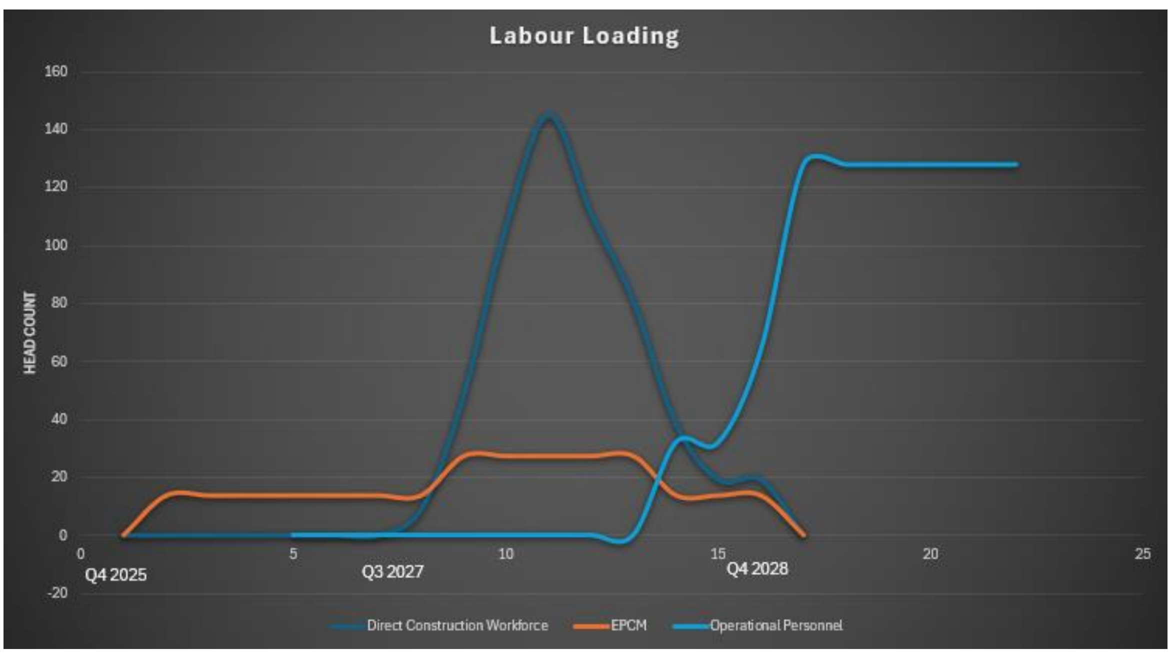
Once construction permits are in hand construction will begin. Construction is anticipated to take 30 months; after 15 months it is anticipated that the calciner and the first train of the hydrometallurgical plant will be ready for commissioning and ramp up. Line two of the hydrometallurgical plant will be constructed and ready to commission nine months after the first line. After commissioning each line is anticipated to take 12 months to ramp up to full production.

The schedule is arranged to optimize production advancement. A more detailed project schedule will be developed in the next project phase.

8.10 Project Labour Loading

A high-level projected labour loading can be seen in Figure 8-2. The loading was estimated by layering the labour hours required for each discipline over the project schedule timeframe. In future phases, as schedules and labour requirements are refined, so will the labour loading projections.

Figure 8-2 – Projected Labour Loading



Peak construction labour on site during the project is projected to be 173 people. When factoring in operational personnel for commissioning and ramp up at the end of construction, the peak labour loading onsite is projected to be 236 people including those operating the plant and administrative staff.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The PEA indicates a strong financial case to proceed to the next phase of the Lake Superior Lithium project. The following conclusions can be drawn from the study:

- The development capital cost (Class 5 estimate accuracy) is anticipated to be CAD$1.213 billion.
- The steady state operating cost for the plant is anticipated to be CAD$13,029/t of lithium hydroxide monohydrate (LHM) produced (including spodumene purchase and transport costs).
- The after tax NPV (8%) and IRR for the 30-year life of project are anticipated to be CAD4.12 billion and 47.5% respectively. The financial model is most sensitive to LHM sale price and less so to Opex and capital costs.
- The industrial land purchased for the project (Project site) is suitable for adapting the existing infrastructure and building additional infrastructure. It is already well serviced by road, deep-water port, rail, power and all utilities.

9.2 Recommendations

DRA provides the following recommendations:

- Avalon to proceed with the Feasibility Study as soon as possible to maintain the desired project timeframe (Operations start in 2028)
- Avalon to source feed material from various likely spodumene sources to test the makeup of the material and how it will react in the Metso processes.
- Avalon to approach potential recipients of the analcime byproduct to better define where and how this material might be used downstream of the process.
- Avalon to begin baseline studies to advance permitting as quickly as practical.
- Avalon to kick-off geotechnical investigation for The Property to support the feasibility study civil design.
- Avalon to investigate the viability of a solar farm on the Avalon industrial site. As much as 37 acres of non-productive and unusable industrial land within the landfill site footprint could be repurposed for use as a solar farm. Additional area on roof tops of the processing facilities could also be utilized for solar collection. The goal would be to maximize power generation to potentially match and/or exceed the power requirements for the processing facility while feeding any excess electrical energy into the electrical grid. The benefits would allow Avalon to reduce the carbon impact by offsetting the industrial carbon footprint and driving the

production of battery grade lithium hydroxide from the Avalon site to an ultra high-quality clean energy product.

10 REFERENCES

10.1 Metso PEA Deliverables

Material Balance, Hydrometallurgical Lithium Plant, General, July 10, 2024, 905739_HLP01_ZZ01_PED07_00001_R2

Main Process Equipment List, All Areas, General, July 12, 2024, 905739_HLP01_ZZ01_BPC01_00001_R2

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Plot Plan, Hydrometallurgical Processing Plant, General, Plan View, June 17, 2024, 20240617_Avalon_LiOH-Monochrome

Block Diagram, All Areas, General, Block Diagram, July 10, 2024, 905739_ZZ01_ZZ01_PFA01_00001_R1

Process Description, Hydrometallurgical Lithium Plant, General, June 10, 2024, 905739_HLP01_ZZ01_PDB05_00001_R1

List of Utilities and Consumables, Hydrometallurgical Plant, General, July 17, 2024, 905739_HLP01_ZZ01_PEC04_00001_R3

10.2 Environmental Studies, Permitting and Social or Community Impact

Canada Gazette, Part 2, Volume 153, Number 17: Physical Activities Regulations, August 21, 2019

CSL. 2024a. Draft 2023 Stormwater Monitoring Report prepared by CSL Environmental & Geotechnical Ltd. March 2024

CSL. 2024b. Draft 2023 Groundwater Monitoring Report prepared by CSL Environmental & Geotechnical Ltd. March 2024

Environment Canada July 2024, website Thunder Bay, ON - 7 Day Forecast - Environment Canada (weather.gc.ca)

Geology Ontario July 2024. Website https://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd126/doc.kml

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SLR, Avalon Lithium Plant PEA, Environmetal Studies and Permitting, August 29, 2024, 241.031639.00001

Appendix A –
Reagents, Utilities, Effluents, and Residue Specifications

Rev	Prepared Name	Prepared Date	Checked Name	Checked Date	Released Name	Released Date	Revision Text
03	AzaRO	17.07.2024	Petritai	17.07.2024	Maritih	17.07.2024	R3
02	AzaRO	18.06.2024	Petritai	18.06.2024	Maritih	18.06.2024	R2
01	AzaRO	12.06.2024	Petritai	12.06.2024	Maritih	12.06.2024	R1
00	AzaRO	30.05.2024	Petritai	30.05.2024	Maritih	30.05.2024	R0

Status:

Original Size: A4

Customer: AVALON ADVANCED MATERIALS

Project Lifecycle Phase: Desktop study

Site No.:

Project Name: AVALON DRA LiOH Plant

Customer Document ID:

Replaced by:

Replaces:

Language: EN

Document Title:

LIST OF UTILITIES AND CONSUMABLES

HYDROMETALLURGICAL LITHIUM PLANT

GENERAL

Equipment No:

Item No:

Project ID:	Plant Code:	Plant Unit Code:	Document Type:	Running No:	Revision:	Sheet of Sheets:
905739	HLP01	ZZ01	PEC04	00001	R3	1 (8)

Metso Document ID:

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1. GENERAL

The raw material of the Lithium Hydroxide production plant is spodumene concentrate. The product of the process is battery-grade lithium Hydroxide monohydrate.

The Lithium Hydroxide plant will be based on Metso's proprietary technologies which include calcination, pressure leaching, conversion, and ion exchange process stages. The vendor will provide data for the lithium hydroxide crystallization, drying and packing areas of the plant to produce battery-grade lithium hydroxide monohydrate.

Metso technologies will result in a compact footprint lithium hydroxide production plant with optimized energy efficiency and low chemical consumption to produce the target 30,000 metric tons per annum(tpa) of battery-grade lithium hydroxide monohydrate (LHM) in two lines of approximately 15000 tpa of LHM.

The Avalon Advanced Materials Lithium hydroxide monohydrate mass and energy balance have been calculated by using Metso's HSC-Sim software, a flowsheet simulation tool. HSC contains an extensive thermochemical database that has enthalpy (H), entropy (S) and heat capacity (Cp) data for more than 28,000 chemical species. Balance considers the incoming streams compositions and temperatures, as well as the chemical reactions in units.

The calculation has been made for a nominal concentrate feed of 26.6 tons per hour (200000 tpa) of dry concentrate alpha spodumene feed with 6.0 % Li_2O content targeting a production of 30,000 tpa of lithium hydroxide monohydrate (LHM). The availability has been assumed to be 7500 h/a (=85.6%) for the plant's nominal capacity. The Summary of continuous nominal reagent and utility consumption is presented for both trains.

The raw material, utilities and reagents consumption figures are based on mass balance simulation. Some utilities and consumables have been estimated based on Metso's experience in similar technology engineering and delivery cases.

2. CONSUMPTION OF REAGENTS AND UTILITIES

Utility and reagent specifications and requirements are defined in the document Process design criteria (905739_ZZZ01_ZZ01_PEC02_00001_R1). **The Summary of continuous nominal reagent and utility consumption is presented in chapters 2.1 to 2.3 for both trains**. The total consumables are given for calcination and hydrometallurgical lithium hydroxide plant and crystallization. All of the known significant instantaneous consumptions and start-up consumptions are also indicated as notes in the text.

2.1. Utilities

2.1.1. Demi Water

Demineralized water is used in autoclave agitator sealing and in ion exchange area washes and reagent dilutions. Additionally, crystallization area needs demi water in start-up.

Description	Unit	Nominal	Source	Rev
Demi water total	**t/h**	**9.2**	**Calc**	**03**

Note:

LiOH crystallization plant: instantaneous start-up consumption is 2 t/h of demi water.

2.1.2. Fresh Water

Fresh water is used throughout the process in different locations mainly as a make-up water and sealing water.

Description	Unit	Nominal	Source	Rev
Calcination Gas Cleaning	t/h	23.7(TBD)	V	00
Pump Sealing Water	t/h	20	Calc	00
Freshwater Hydro	t/h	27.6	Calc	00
Freshwater total	**t/h**	**71.3**	**Calc**	**00**

2.1.3. Cooling Water

Cooling water is used in the cooling of the leached slurry before conversion and in crystallization condensate cooling.

Description	Unit	Nominal	Source	Rev
Calcination	t/h	7	Calc	00
Calcine Cooler	t/h	395	Calc	00
Cooling water Hydro	t/h	453.12	Calc	00
Cooling water Crystal	t/h	50.5(TBD)	Calc	00
total	**t/h**	**905.6**	**Calc**	**00**

2.1.4. Steam

2.1.4.1. HP steam

The total high-pressure steam consumption is 28 brag, (assumed saturated) steam from the battery limit.

Description	Unit	Nominal	Source	Rev
HP Steam feed autoclave	**t/h**	**14.7**	**Calc**	**00**

Note: instantaneous 5 t/h feed of HP steam for the autoclave plant is needed in the start-up

2.1.4.2. MP steam

The total medium-pressure steam consumption is given as 10 barg, (assumed saturated) steam from the battery limit. In the autoclave area, MP steam is used in the start-up heat source.

Description	Unit	Nominal	Source	Rev
MP Steam to crystallization	**t/h**	**1.5 (TBD)**	**V**	**00**

Note: additional MP steam will be needed instantaneously in the autoclave and crystallization plant start-ups. Start-up steam is estimated:

6 t/h MP steam for autoclave plant (pre-heater)

2-3 t/h MP steam for LiOH crystallizer plant.

2.1.4.3. LP steam

The low-pressure steam consumption is given as 4 barg, (assumed saturated) steam from the battery limit. Low-pressure steam is used in the crystallization process.

Description	Unit	Nominal	Source	Rev
LP Steam	**t/h**	**4(TBD)**	**V**	**02**

2.1.5. CFA

Carbon-free air is used as a blanketing gas for tanks and reactors in the conversion area to prevent lithium reaction with carbon dioxide to carbonate.

Description	Unit	Nominal	Source	Rev
CFA	**Nm3/h**	**1360**	**Calc**	**00**

2.1.6. Instrument Air

All the values are reported at 0 C and 100 kPa.

Description	Unit	Nominal	Source	Rev
Instrument air	**Nm3/h**	**1500**	**Metso**	**00**

2.1.7. Plant Air

All the values are reported at 0 C and 100 kPa.

Description	Unit	Nominal	Source	Rev
Plant air total	**Nm3/h**	**2400**	**Metso**	**00**

Notes:

Plant air is regularly fed to the beta-spodumene loss-in-weight feeder screw and weighing bin cone. The instantaneous consumption (fluidization time = approx. 1 minute), for the feeder to start is 150 Nm^3/h. Approximately the same amount 150 Nm3/h of air is also fed to the bin bottom for material fluidization instantaneously, at the start.

2.1.8. Electricity

Electricity consumption is estimated as average absorbed power:

Description	Unit	Consumption	Installed	Source	Rev
Electricity	**hp**	**11430**	**17590**	**Metso**	**03**

2.2. Reagent

2.2.1. Fuel

Natural Gas

Description	Unit	Nominal	Source	Rev
Calcination	**Nm3/h**	**1915**	**Calc**	**00**

2.2.2. Sodium Carbonate

Consumption of solid sodium carbonate (100 %) is used as a leaching agent in pressure leaching.

Description	Unit	Nominal	Source	Rev
Na_2CO_3	**t/h**	**5.4**	**Calc**	**00**

2.2.3. Sodium Hydroxide

Sodium hydroxide (50%) is used in ion exchange and effluent neutralization before lithium recovery.

Description	Unit	Nominal	Source	Rev
NaOH (50%)	**t/h**	**0.06**	**Calc**	**00**

2.2.4. Calcium oxide

Calcium oxide is used in primary and secondary conversion.

Description	Unit	Nominal	Source	Rev
CaO	**t/h**	**4.2**	**Calc**	**00**

2.2.5. Hydrochloric Acid

Hydrochloric acid (33%) is used in ion exchange elution.

Description	Unit	Nominal	Source	Rev
HCl (33%)	**t/h**	**0.3**	**Calc**	**01**

2.2.6. Carbon dioxide

Carbon dioxide is used in mother liquor to purge carbonation. Consumption is given as 100% CO_2 gas.

Description	Unit	Nominal	Source	Rev
CO_2	**t/h**	**0.4**	**Calc**	**00**

2.3. Consumables

Other consumables that are required to operate the plant are:

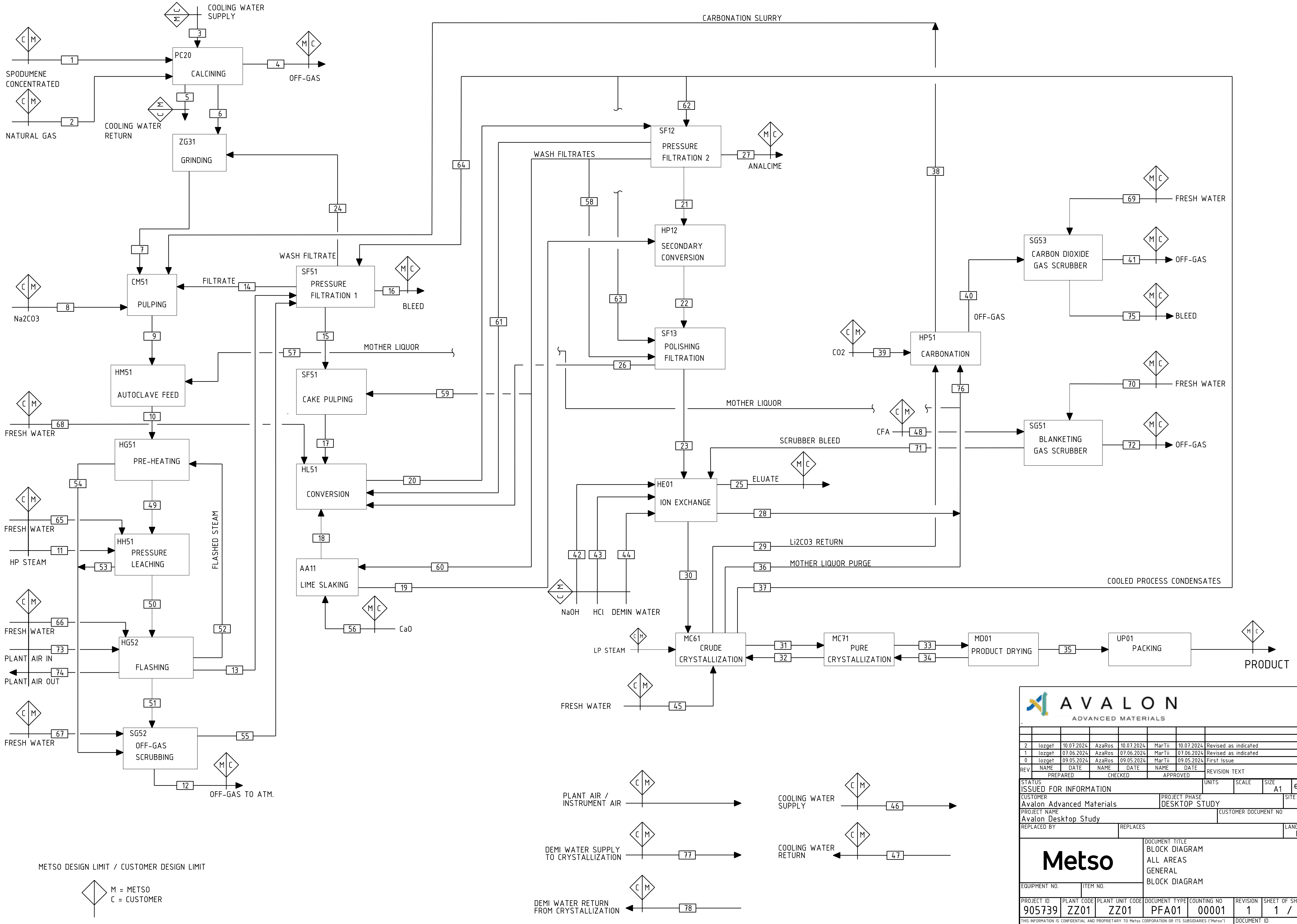
Calcination

- Cartridge filters for dust collectors with fans, located at storage bins and cooler discharge hood.
- Grinding media
- Additional consumables may be required for gas cleaning equipment

Hydro

- Filter cloths for all filters
- Ion exchange resin: Lewatit MDS TP208 total inventory is 64 m^3, in Na-form
- Crystallizer plant cleaning acid: assumed corrosion inhibitor to hydrochloric acid. One cleaning liquid batch is estimated to be 25 m3 inventory (can be used several times). Other options are sulphuric acid, sulfamic acid, and TBC by Vendor.

Appendix B – Block Flow Diagram



AVALON ADVANCED MATERIALS

REV	NAME	DATE	NAME	DATE	NAME	DATE	REVISION TEXT
2	lozget	10.07.2024	AzaRos	10.07.2024	MarTii	10.07.2024	Revised as indicated
1	lozget	07.06.2024	AzaRos	07.06.2024	MarTii	07.06.2024	Revised as indicated
0	lozget	09.05.2024	AzaRos	09.05.2024	MarTii	09.05.2024	First Issue
	PREPARED		CHECKED		APPROVED		

STATUS: ISSUED FOR INFORMATION | UNITS | SCALE | SIZE: A1
CUSTOMER: Avalon Advanced Materials | PROJECT PHASE: DESKTOP STUDY | SITE NO
PROJECT NAME: Avalon Desktop Study | CUSTOMER DOCUMENT NO
REPLACED BY | REPLACES | LANGUAGE: EN

Metso

DOCUMENT TITLE: BLOCK DIAGRAM ALL AREAS GENERAL BLOCK DIAGRAM

EQUIPMENT NO. | ITEM NO.

PROJECT ID	PLANT CODE	PLANT UNIT CODE	DOCUMENT TYPE	COUNTING NO	REVISION	SHEET OF SHEETS
905739	ZZ01	ZZ01	PFA01	00001	1	1 / 1

DOCUMENT ID

Metso A1 ISO 5457

Appendix C – Mass Balance

AVALON
ADVANCED MATERIALS

02	AzaRos	12.07.2024	Petrzeit	10.07.2024	Maritih	10.07.2024	R2
01	AzaRos	10.06.2024	Petrzeit	10.06.2024	Maritih	10.06.2024	R1
00	AzaRos	16.05.2024					R0
Rev	Name	Date	Name	Date	Name	Date	Revision Text
	Prepared		Checked		Released		

Status:		Original Size: A4
Customer: AVALON ADVANCED MATERIALS	Project Lifecycle Phase: Desktop study	Site No.:
Project Name: AVALON LiOH plant	Customer Document ID:	
Replaced by:	Replaces:	Language: EN

Metso

Document Title:

MATERIAL BALANCE

HYDROMETALLURGICAL LITHIUM PLANT

GENERAL

Equipment No:	Item No:

Project ID:	Plant Code:	Plant Unit Code:	Document Type:	Running No:	Revision:	Sheet of Sheets:
905739	HLP01	ZZ01	PED07	00001	R2	1 (12)

Metso Document ID:

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1. GENERAL

Avalon Advanced Materials calcination and hydrometallurgical processing plant mass balance is shown in the following flow tables, in chapter 2.

The streams have been numbered according to the process block diagram and the main parameters and components of each stream are shown. The plant-wide block diagram is found in the following document:

905739_ZZZ01_ZZ01_PFA01_00001_R1

Lithium is leached in the process, solubilized and recovered as battery-grade lithium hydroxide monohydrate. The total targeted production is 30,000 metric tons per annum of battery-grade lithium hydroxide monohydrate (LHM). The hydrometallurgical part is done with two lines of approximately 15,000 tpa lithium hydroxide monohydrate process plants to reach this capacity. The calculations have been made for a nominal concentrate feed of 13.333 tons per hour (100000 tpa) of beta-spodumene calcine feed with 6.0% Li2O content, targeting production of approximately 15 000 tpa lithium hydroxide monohydrate (LHM) for one line of LHM process plant. The plant availability has been assumed to be 7500 h/a for the nominal capacity.

The Hydrometallurgical Plant mass and energy balance have been calculated by using Metso’s HSC-Sim software, a flowsheet simulation tool. HSC contains an extensive thermochemical database that has enthalpy (H), entropy (S) and heat capacity (Cp) data for more than 28,000 chemical species. Energy balances have been calculated by considering the incoming streams compositions as well as the chemical reactions. The resulting stream compositions and temperatures are shown in the process flow tables. HSC-Sim has built-in functions for stream density estimation based on literature reference data.

2. MASS BALANCE TABLES

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Stream No.		1	2	3	4	5
Designation	**Unit**	**Feed Alpha spodumene concentrated**	**Natural gas to rotary kiln**	**cooling water to rotary kiln cooler**	**stack Inlet gas calcinatio n**	**cooling water return from cooler**
Nominal mass flow	t/h	29,49	1,2	394,99	36,37	394,99
Nominal flow	m3/h			395,65	34398	395,65
Temperature	ºC		20	30	75	46,11
Solid concentration	g/L					
Solid concentration	wt-%	88				
Solids mass flow rate	t/h					
Liquid mass flow rate	t/h	4,02				
Gas flow rate	Nm3/h		1706,4			
Net Heat Rate	kWh		16998			
Gross Heat Rate	kWh		18756			
Stream Heat content	kWh			4592		11927
Notes		TBD	TBD	TBD	TBD	TBD

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Stream No.		6	7	8	9	10	11	12	13	14	15
Designation		Beta Spodumene to grinding	Ground Beta spodumene to pulping	Sodium carbonate to pulping	Slurry from pulping to autoclave feed	Slurry to pre-heater	HP steam to autoclave	Pressure leach off-gas	Cooled slurry to filtration	1st stage filtrate to pulping	1st stage flter cake
Nominal mass flow	t/h	13,3	33,3	2,69	57,6	57,8	7,37	6,6	58,9	18,9	21,5
Nominal flow	m3/h	5,5	25,6	1,06	45,7	45,9	9287 Nm3/h	8310 Nm3/h	49,4	19,1	11,7
Temperature	°C	80	83,2	25	89,3	89,3	232	96	87	83,7	79,1
Solid concentration	g/L	2423	520	2531	297	296	0	0	349	0	1464
Solid concentration	wt-%	100	40	100	23,6	23,5	0	0	29,3	0	80
Solids mass flow rate	t/h	13,3	13,3	2,69	13,6	13,6	0	0	17,3	0	17,2
Liquid mass flow rate	t/h	0	20	0	44	44,2	0	0	41,7	18,9	4,3
Normal gas flow	Nm3/h	0	0	0	0	0	9287	8310	0	0	0
Solution composition											
Li+	g/L	0	1,46	0	1,5	1,59	0	0	1,41	1,46	1,51
K	g/L	0	0,87	0	1,08	1,1	0	0	0,99	0,86	0,15
Mg	g/L	0	0	0	0	0	0	0	0	0	0
Ca	g/L	0	0,0048	0	0,0057	0,0057	0	0	0,0055	0,0048	0,0008
Na+	g/L	0	2,53	0	32,4	32,3	0	0	2,9	2,53	0,44
Solids composition											
Li	wt-%	2,79	2,79	0	3,08	3,08	0	0	2,45	0	2,38
K	wt-%	0,43	0,43	0	0,43	0,43	0	0	0,35	0	0,35
Mg	wt-%	0,12	0,12	0	0,12	0,12	0	0	0,093	0	0,094
Ca	wt-%	0,61	0,61	0	0,6	0,6	0	0	0,47	0	0,47
Na	wt-%	0,44	0,44	43,4	0,43	0,43	0	0	7,18	0	7,21
Slurry density	kg/m3	2423	1300	2531	1260	1259	0	0	1192	993	1831
Liquid density	kg/m3	0	994	0	1098	1098	0	0	992	993	990
Solid density	kg/m3	2423	2423	2531	2416	2416	0	0	2322	0	2323
Notes		Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Periodic

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Stream No.		**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Designation		**1 stage filter Bleed**	**Conversion feed**	**Lime milk to conversion**	**Lime milk to second conversion**	**Conversion slurry to filtration**	**Second stage filtrate to second conversion**	**Second convesion slurry to polishing filter**	**Filtrate to Ion Exchange**	**1st stage wash filtrate to grinding**	**Ion Exchange Eluate**
Nominal mass flow	t/h	7,15	33,1	10,4	5,1	67,4	41	46,1	44,6	20	0,78
Nominal flow	m3/h	7,19	23,5	9,39	4,61	55,1	39,8	44,4	43,4	20,1	0,7
Temperature	ºC	85	57	40	40	43,4	43,4	43,1	43,1	83,7	30
Solid concentration	g/L	0	732	199	199	336	0	20,8	0	0	0
Solid concentration	wt-%	0	51,9	18	18	27,4	0	2	0	0	0
Solids mass flow rate	t/h	0	17,2	1,87	0,92	18,5	0	0,92	0	0	0
Liquid mass flow rate	t/h	7,15	15,9	8,52	4,18	48,9	41	45,2	44,6	20	0,78
Normal gas flow	Nm3/h	0	0	0	0	0	0	0	0	0	0
Solution composition											
Li+	g/L	1,44	0,71	0,44	0,44	9,75	9,75	8,87	8,87	1,46	0,94
K	g/L	0,99	0,048	0,095	0,095	0,25	0,25	0,24	0,24	0,86	0
Mg	g/L	0	0	0	0	0	0	0	0	0	0
Ca	g/L	0,0055	0,0008	0,053	0,053	0,02	0,02	0,035	0,035	0,0048	2,11
Na+	g/L	2,91	0,15	0,71	0,71	0,9	0,9	0,88	0,88	2,53	11,5
Solids composition											
Li	wt-%	0	2,38	0	0	0,15	0	0	0	0	0
K	wt-%	0	0,35	0	0	0,28	0	0	0	0	0
Mg	wt-%	0	0,094	0	0	0,087	0	0	0	0	0
Ca	wt-%	0	0,47	54,1	54,1	8,59	0	53,9	0	0	0
Na	wt-%	0	7,21	0	0	6,54	0	0	0	0	0
Slurry density	kg/m3	993	1411	1106	1106	1224	1029	1038	1026	993	1118
Liquid density	kg/m3	993	991	996	996	1029	1029	1026	1026	993	1118
Solid density	kg/m3	0	2323	2240	2240	2449	0	2245	0	0	0
Notes		Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous

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Stream No.		26	27	28	29	30	31	32	33	34	35
Designation		Polishing filter cake slurry to convesion	Analcime to cake discharge	Li2CO3 slurring liquid	Li2CO3 return from crystallization to carbonation	IX product to crystallization	Crude crystallization slurry to pure crystallization	Pure crystallization ML return to crude crystallization feed tank	Pure crystallization slurry to product drying	Dryer condensate return to pure crystallization	LHM product to packing
Nominal mass flow	t/h	5,2	26,4	0,91		44,5	17,5	19,8	2,06		2
Nominal flow	m3/h	4,72	15,5	0,92		43,4	16,4	18,3	1,38		1,33
Temperature	°C	50,1	40,8	39,7		42,9	88,8	87,5	34		50
Solid concentration	g/L	195	1191	0		0	0	0	1443		1506
Solid concentration	wt-%	17,7	70	0		0	0	0	97		99,8
Solids mass flow rate	t/h	0,92	18,5	0		0	0	0	2		2
Liquid mass flow rate	t/h	4,28	7,93	0,91		44,5	17,5	19,8	0,062		0,0038
Normal gas flow	Nm3/h	0	0	0		0	0	0	0		0
Solution composition											
Li+	g/L	1,3	0,19	0		8,86	30,8	31	4,68		0
K	g/L	0,034	0,0048	0,1		0,23	0,04	0,11	0,017		0
Mg	g/L	0	0	0		0	0	0	0		0
Ca	g/L	0,0049	0,0004	0,0004		0,001	0	0	0		0
Na+	g/L	0,13	0,017	0,55		0,87	0,17	0,5	0,075		0,044
Solids composition											
Li	wt-%	0	0,15	0		0	0	0	16,5		16,5
K	wt-%	0	0,28	0		0	0	0	0,0002		0,0002
Mg	wt-%	0	0,087	0		0	0	0	0		0
Ca	wt-%	53,9	8,59	0		0	0	0	0		0
Na	wt-%	0	6,54	0		0	0	0	0,0005		0,0007
Slurry density	kg/m3	1102	1701	994		1026	1068	1069	1488		1508
Liquid density	kg/m3	994	993	994		1026	1068	1069	1013		988
Solid density	kg/m3	2245	2449	0		0	0	0	1510		1510
Notes		Continuous	Periodic	Continuous	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Stream No.		36	37	38	39	40	41	42	43	44	45
Designation		Mother liqure to ML recycle tank	Cooled condensate from crystallization return to upstream	Carbonation slurry to pulping	Carbon dioxide to carbonation	Carbonation vent to CO2 scrubber	Off gas from CO2 scrubber	NaOH to IX	HCl to IX	Demin water to IX	Fresh water
Nominal mass flow	t/h	1,82	48,4	2,69	0,2	0,058	0,046	0,028	0,15	1,3	4,53
Nominal flow	m3/h	1,63	49,2	2,46	105	65,4	51,1	0,018	0,1	1,32	4,55
Temperature	°C	92	57,7	97,4	25	97,4	96,7	25	25	25	25
Solid concentration	g/L	0	0	103	0	0	0	0	0	0	0
Solid concentration	wt-%	0	0	9,47	0	0	0	0	0	0	0
Solids mass flow rate	t/h	0	0	0,25	0	0	0	0	0	0	0
Liquid mass flow rate	t/h	1,82	48,4	2,43	0	0	0	0,028	0,15	1,3	4,53
Nominal gas flow	Nm3/h	0	0	0	105	65,4	51,1	0	0	0	0
Solution composition											
Li+	g/L	33	0	1,3	0	0	0	0	0	0	0
K	g/L	6,2	0	4,05	0	0	0	0	0	0	0
Mg	g/L	0	0	0	0	0	0	0	0	0	0
Ca	g/L	0,026	0	0,017	0	0	0	0	0	0	0
Na+	g/L	23,1	0	15,2	0	0	0	437	0	0	0
Solids composition											
Li	wt-%	0	0	18,5	0	0	0	0	0	0	0
K	wt-%	0	0	0	0	0	0	0	0	0	0
Mg	wt-%	0	0	0	0	0	0	0	0	0	0
Ca	wt-%	0	0	0	0	0	0	0	0	0	0
Na	wt-%	0	0	0	0	0	0	0	0	0	0
Slurry density	kg/m3	1113	984	1090	0	0	0	1520	1531	997	997
Liquid density	kg/m3	1113	984	1038	0	0	0	1520	1531	997	997
Solid density	kg/m3	0	0	2110	0	0	0	0	0	0	0
Notes		TBD	TBD	Continuous	Continuous	Continuous	Continuous	Continuous	Periodic	Periodic	Continuous

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Stream No.		**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**
Designation		**Cooling water supply**	**Cooling water return**	**CFA to blancketing**	**Preheating to pressure leach**	**Pressure leach to flashing**	**Steam from flashing to off-gas scrubber**	**Recycle steam to pre-heater**	**Autoclave vent**	**Preheater vent**	**scrubber bleed to leach filtration**
Nominal mass flow	t/h	253	253	0,86	63,5	71,7	6,52	6,03	0,13	0,3	3,28
Nominal flow	m3/h	253	254	680 Nm3/h	54,4	67,9	8220 Nm3/h	7598 Nm3/h	147 Nm3/h	380 Nm3/h	3,41
Temperature	°C	25	35	40	156	215	100	165	215	156	96
Solid concentration	g/L	0	0	0	252	257	0	0	0	0	0
Solid concentration	wt-%	0	0	0	21,6	24,3	0	0	0	0	0
Solids mass flow rate	t/h	0	0	0	13,7	17,4	0	0	0	0	0
Liquid mass flow rate	t/h	253	253	0	49,8	54,3	0	0	0	0	3,28
Normal gas flow	Nm3/h	0	0	680	0	0	8220	7598	147	380	0
Solution composition											
Li+	g/L	0	0	0	0,75	0,46	0	0	0	0	0
K	g/L	0	0	0	0,91	0,69	0	0	0	0	0
Mg	g/L	0	0	0	0	0	0	0	0	0	0
Ca	g/L	0	0	0	0,0047	0,0038	0	0	0	0	0
Na+	g/L	0	0	0	26,7	2,02	0	0	0	0	0
Solids composition											
Li	wt-%	0	0	0	3,25	2,61	0	0	0	0	0
K	wt-%	0	0	0	0,42	0,35	0	0	0	0	0
Mg	wt-%	0	0	0	0,12	0,092	0	0	0	0	0
Ca	wt-%	0	0	0	0,59	0,47	0	0	0	0	0
Na	wt-%	0	0	0	0,43	7,11	0	0	0	0	0
Slurry density	kg/m3	997	994	0	1168	1056	0	0	0	0	961
Liquid density	kg/m3	997	994	0	1023	898	0	0	0	0	961
Solid density	kg/m3	0	0	0	2412	2320	0	0	0	0	0
Notes		Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous

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AVALON ADVANCED MATERIALS
MATERIAL BALANCE
HYDROMETALLURGICAL LITHIUM PLANT

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Stream No.		**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**
Designation		**CaO to lime slacking**	**Mother liquor recycle to AC**	**Wash filtrate to polishing**	**Wash filtrate to cake pulping**	**Wash filtrate to Lime slacking**	**Strong wash filtrate to conversion**	**Condensate return to second pressure filter**	**Condensate return to polishing filter**	**Condensate return to leach filtration**	**Fresh water to AC**
Nominal mass flow	t/h	2,13	0,19	1,32	11,6	13,4	14,4	40,7	2,38	5,35	0,87
Nominal flow	m3/h	0,64	0,18	1,32	11,7	13,4	14,2	41,3	2,42	5,43	0,87
Temperature	°C	25	71,5	40,8	40,8	40,8	40,8	57,7	57,7	57,7	25
Solid concentration	g/L	3325	0	0	0	0	0	0	0	0	0
Solid concentration	wt-%	100	0	0	0	0	0	0	0	0	0
Solids mass flow rate	t/h	2,13	0	0	0	0	0	0	0	0	0
Liquid mass flow rate	t/h	0	0,19	1,32	11,6	13,4	14,4	40,7	2,38	5,35	0,87
Normal gas flow	Nm3/h	0	0	0	0	0	0	0	0	0	0
Solution composition											
Li+	g/L	0	21,3	0,42	0,42	0,42	4,39	0	0	0	0
K	g/L	0	4,04	0,011	0,011	0,011	0,11	0	0	0	0
Mg	g/L	0	0	0	0	0	0	0	0	0	0
Ca	g/L	0	0,017	0,0009	0,0009	0,0009	0,009	0	0	0	0
Na+	g/L	0	15,2	0,038	0,038	0,038	0,41	0	0	0	0
Solids composition											
Li	wt-%	0	0	0	0	0	0	0	0	0	0
K	wt-%	0,05	0	0	0	0	0	0	0	0	0
Mg	wt-%	0	0	0	0	0	0	0	0	0	0
Ca	wt-%	70,9	0	0	0	0	0	0	0	0	0
Na	wt-%	0,4	0	0	0	0	0	0	0	0	0
Slurry density	kg/m3	3325	1082	994	994	994	1010	984	984	984	997
Liquid density	kg/m3	0	1082	994	994	994	1010	984	984	984	997
Solid density	kg/m3	3325	0	0	0	0	0	0	0	0	0
Notes		Periodic	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous

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Stream No.		**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**
Designation		**Fresh water to HP flash discharge**	**Fresh water to AC scrubber**	**Fresh water to conversion**	**Fresh water to CO2 scrubber**	**Fresh water to Blanketing gas scrubber**	**Bleed to IX discharge**	**Blanketing gas scrubber off gas**	**Air in**	**Air out**	**CO2 scrubber bleed**
Nominal mass flow	t/h	0,86	2,93	4,31	0,086	0,16	0,15	0,87	1,03	2,11	0,097
Nominal flow	m3/h	0,86	2,94	4,32	0,086	0,16	0,15	693 Nm3/h	814 Nm3/h	2173 Nm3/h	0,1
Temperature	ºC	25	25	25	25	25	16,8	16,8	25	87	96,7
Solid concentration	g/L	0	0	0	0	0	0	0	0	0	0
Solid concentration	wt-%	0	0	0	0	0	0	0	0	0	0
Solids mass flow rate	t/h	0	0	0	0	0	0	0	0	0	0
Liquid mass flow rate	t/h	0,86	2,93	4,31	0,086	0,16	0,15	0	0	0	0,097
Normal gas flow	Nm3/h	0	0	0	0	0	0	693	814	2173	0
Solution composition											
Li+	g/L	0	0	0	0	0	0	0	0	0	0
K	g/L	0	0	0	0	0	0	0	0	0	0
Mg	g/L	0	0	0	0	0	0	0	0	0	0
Ca	g/L	0	0	0	0	0	0	0	0	0	0
Na+	g/L	0	0	0	0	0	0	0	0	0	0
Solids composition											
Li	wt-%	0	0	0	0	0	0	0	0	0	0
K	wt-%	0	0	0	0	0	0	0	0	0	0
Mg	wt-%	0	0	0	0	0	0	0	0	0	0
Ca	wt-%	0	0	0	0	0	0	0	0	0	0
Na	wt-%	0	0	0	0	0	0	0	0	0	0
Slurry density	kg/m3	997	997	997	997	997	999	0	0	0	961
Liquid density	kg/m3	997	997	997	997	997	999	0	0	0	961
Solid density	kg/m3	0	0	0	0	0	0	0	0	0	0
Notes		Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous

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Stream No.		**76**	**77**	**78**
Designation		**Dilute Mother liqure to carbonation**	**Demi water supply to crystallization**	**Demi water return from crystallizatio n**
Nominal mass flow	t/h	2,54	3,27	3,27
Nominal flow	m3/h	2,35	3,27	3,27
Temperature	ºC	71,5	25	25
Solid concentration	g/L	0	0	0
Solid concentration	wt-%	0	0	0
Solids mass flow rate	t/h	0	0	0
Liquid mass flow rate	t/h	2,54	3,27	3,27
Nominal gas flow	Nm3/h	0	0	0
Solution composition				
Li+	g/L	21,3	0	0
K	g/L	4,04	0	0
Mg	g/L	0	0	0
Ca	g/L	0,017	0	0
Na+	g/L	15,2	0	0
Solids composition				
Li	wt-%	0	0	0
K	wt-%	0	0	0
Mg	wt-%	0	0	0
Ca	wt-%	0	0	0
Na	wt-%	0	0	0
Slurry density	kg/m3	1082	0	0
Liquid density	kg/m3	1082	997	997
Solid density	kg/m3	0	0	0
Notes		Continuous	TBD	TBD

Appendix D – Process Plant Plot Plan

0 10 20m

PRELIMINARY FOOTPRINT ESTIMATION
NOT FOR CONSTRUCTION

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETER, CO-ORDINATES AND ELEVATION ARE IN METERS U.O.S.

2. SITE LEVEL/FINISHED GROUND LEVEL (F.G.L) = (-)0.500m
FINISHED FLOOR LEVEL (F.F.L) = (±)0.500m

3. ALL ELEVATIONS ARE IN METERS ABOVE SEA LEVEL

4. EQUIPMENT AND BUILDING DIMENSIONS AND HEIGHTS ARE PRELIMINARY AND SHALL BE FINALIZED DURING FURTHER ENGINEERING PHASES

5. ALL MAINTENANCE FACILITIES, HANDLING PROVISIONS, ACCESS WAYS, PLATFORMS FOR MAINTENANCE SHALL BE PROVIDED DURING FURTHER ENGINEERING PHASES WHICH ARE NOT SHOWN ENTIRELY

REV.	PREPARED NAME	PREPARED DATE	CHECKED NAME	CHECKED DATE	APPROVED NAME	APPROVED DATE	REVISION TEXT
1	HANMUL	17.06.2024					PRELIMINARY, UPDATED
0	HANMUL	14.05.2024					PRELIMINARY

STATUS: PRELIMINARY	UNITS: mm	SCALE: 1:500	SIZE: A0
CUSTOMER:	PROJECT PHASE: STUDY 01	SITE NO:	
PROJECT NAME: AVALON (DRA) LiOH	CUSTOMER DOCUMENT NO:		
REPLACED BY:	REPLACES:	LANGUAGE: EN	

Metso

DOCUMENT TITLE
PLOT PLAN
HYDROMETALLURGICAL PROCESSING PLANT
GENERAL
PLAN VIEW

EQUIPMENT NO.	ITEM NO.					
PROJECT ID	PLANT CODE	PLANT UNIT CODE	DOCUMENT TYPE	COUNTING NO	REVISION	SHEET OF SHEETS
				00001	1	1 / 1

DOCUMENT ID

Metso:Outotec A0 ISO 5457

Appendix E – Single Line Diagrams

SINGLE-LINE DIAGRAM LEGEND

- (3) PHASE CURRENT TRANSFORMER (QUANTITY 3)
- (1) ZERO SEQUENCE CURRENT TRANSFORMER (QUANTITY 1)
- POWER TRANSFORMER
- VACUUM CIRCUIT BREAKER
- 52 SF6 CIRCUIT BREAKER
- AIR CIRCUIT BREAKER (E)
- CIRCUIT BREAKER
- FUSE
- NON-FUSED LOAD INTERRUPTER SWITCH
- G.S. GROUND SWITCH
- M MOTORIZED DISCONNECT SWITCH
- FUSED CUT OUT
- CABLE TERMINATION
- BUS DUCT
- NGR NEUTRAL GROUND RESISTOR
- MEDIUM OR LOW VOLTAGE STARTER
- CABLE TERMINATION
- K MECHANICAL INTERLOCK
- 3 PHASE STAR CONNECTION TRANSFORMER WITH NEUTRAL GROUNDED THROUGH RESISTOR
- 3 PHASE DELTA CONNECTION TRANSFORMER
- O.H. OVERHEAD LINE
- POTENTIAL TRANSFORMER
- (2) OPEN DELTA (QUANTITY 2) POTENTIAL TRANSFORMER
- TS C.T TEST SWITCH
- VOLTAGE LED LAMP

- DRAWOUT STABS
- CONTACTOR, NORMALLY OPEN
- N.O. NORMALLY OPEN
- N.C. NORMALLY CLOSED
- T B TEST BLOCK
- DELTA CONNECTION
- OPEN DELTA CONNECTION
- WYE CONNECTION
- LIGHTNING ARRESTOR
- SURGE SUPPRESSOR
- CAPACITOR BANK
- DCS DISTRIBUTED CONTROL SYSTEM
- SIS SAFETY INSTRUMENT SYSTEM
- CABLE TERMINATION
- P OVERHEAD POWER LINE POLE
- MPR MOTOR PROTECTION RELAY (EX MULTILIN 269+)
- E TIE BREAKER
- DEAD END STRUCTURE
- FUSE DISCONNECT SWITCH
- 125 VDC + − BATTERY
- R PILOT LIGHT (R=RED, G=GREEN, W=WHITE, A=AMBER)
- VS VOLTMETER SWITCH
- AS AMMETER SWITCH
- ANN ANNUNCIATOR
- EM ELECTRONIC METERING
- K KEY INTERLOCK
- V VOLTMETER
- A AMMETER
- GFR GROUND FAULT PROTECTION RELAY
- VFD VARIABLE FREQUENCY DRIVE
- RTD RESISTANCE TEMPERATURE DETECTOR
- LSIA LONG, SHORT, INSTANTANEOUS ALARM UNIT
- LSIG LONG, SHORT, INSTANTANEOUS GROUND FAULT UNIT
- DISTRIBUTION PANEL
- BATTERY CHARGER
- * RELAY (* – SEE SWITCHGEAR DEVICE NUMBER)
- GROUNDING SWITCH
- REMOVABLE TEST LINK

MOTORS & GENERATORS

- 10 INDUCTION MOTOR SHOWING HORSEPOWER RATING
- WOUND ROTOR MOTOR
- SYNCHRONOUS MOTOR
- DC MOTOR
- GENERATOR
- MOTOR SPACE HEATER
- RTD RESISTANCE TEMP. DETECTOR
- S.C.R.–SILICON CONTROLLED RECTIFIER
- 10 kW LOAD, NON-MOTOR LOAD OR GROUP LOAD IN kW

ABBREVIATION

ATR – AUXILIARY TRANSFORMER
HCB – HV CIRCUIT BREAKER
MCB – MV CIRCUIT BREAKER
LCB – LV CIRCUIT BREAKER
DP – DISTRIBUTION PANEL
DS – DISCONNECT SWITCH
FDS – FUSE DISCONNECT SWITCH
GS – GROUNDING SWITCH
K – KEY INTERLOCK
LA – LIGHTNING ARRESTER
LBS – LOAD BREAK SWITCH
MCOV – MAXIMUM CONTINUOUS OPERATING VOLTAGE
GE – GENERATOR
NGR – NEUTRAL GROUND RESISTOR
PFC – POWER FACTOR CORRECTION
TX – TRANSFORMER
SWG – SWITCHGEAR
ER – ELECTRICAL ROOM
DB – DISTRIBUTION BOARD
MCC – MOTOR CONTROL CENTER

SWITCHGEAR DEVICE NUMBERS

DEV. No.	FUNCTION
1.	–MASTER ELEMENT
2.	–TIME–DELAY STARTING OR CLOSING RELAY
3.	–CHECKING OR INTERLOCKING RELAY
4.	–MASTER CONTACTOR OR RELAY
5.	–STOPPING DEVICE
6.	–STARTING CIRCUIT BREAKER, CONTROLLER, OR SWITCH
7.	–ANODE CIRCUIT BREAKER
8.	–CONTROL POWER SWITCH
9.	–REVERSING DEVICE
10.	–UNIT SEQUENCE SWITCH
11.	–CONTROL POWER TRANSFORMER
12.	–OVERSPEED DEVICE
13.	–SYNCHRONOUS–SPEED DEVICE
14.	–UNDERSPEED DEVICE
15.	–SPEED OR FREQUENCY MATCHING DEVICE
16.	–BATTERY–CHARGING DEVICE
17.	–SHUNTING OR DISCHARGE SWITCH
18.	–ACCEL. OR DECEL. C/B CONTACTOR OR RELAY
19.	–START. TO RUN. TRAN. CONTACTOR OR RELAY
20.	–ELECTRICALLY OPERATED VALVE
21.	–DISTANCE RELAY
22.	–EQUALIZER CIRCUIT BREAKER OR CONTACTOR
23.	–TEMPERATURE REGULATING DEVICE
24.	–VOLTS/HERTZ RELAY
25.	–SYNCHRONIZING OR SYNCHRONISM–CHECK DEVICE
26.	–APPARATUS THERMAL DEVICE
27.	–AC UNDERVOLTAGE RELAY
28.	–RESISTOR THERMAL DEVICE
29.	–ISOLATING CIRCUIT BREAKER, CONTACTOR OR SWITCH
30.	–ANNUNCIATOR RELAY
31.	–SEPARATE EXCITATION DEVICE
32.	–DIRECTIONAL POWER RELAY OR DEVICE
33.	–POSITION SWITCH
34.	–MASTER SEQUENCE DEVICE
35.	–BRUSH–OPERATING OR SLIP–RING SHORT CIRCUITING DEVICE
36.	–POLARITY OR POLARIZING DEVICE
37.	–UNDERCURRENT OR UNDERPOWER RELAY
38.	–BEARING PROTECTIVE DEVICE
39.	–FIELD–REDUCING CONTACTOR
40.	–FIELD RELAY
41.	–FIELD CIRCUIT BREAKER, CONTACTOR OR SWITCH
42.	–RUNNING CIRCUIT BREAKER, CONTACTOR OR SWITCH
43.	–MANUAL TRANSFER DEVICE
44.	–UNIT SEQUENCE STARTER, CONTROLLER OR RELAY
45.	–DC OVERVOLTAGE RELAY
46.	–REVERSE–PHASE, PHASE–BALANCE CURRENT, OR POWER RECTIFIED MISFIRE RELAY
47.	–SINGLE OR REVERSE–PHASE VOLTAGE RELAY
48.	–INCOMPLETE SEQUENCE RELAY
49.	–AC THERMAL RELAY OR DEVICE
50.	–INSTANTANEOUS OVERCURRENT OR RATE OF RISE RELAY
51.	–AC OVERCURRENT RELAY
52.	–AC CIRCUIT BREAKER OR CONTACTOR
53.	–EXCITER OR GENERATOR RELAY
54.	–HIGH SPEED DC CIRCUIT BREAKER
55.	–POWER–FACTOR RELAY
56.	–FIELD APPLICATION RELAY OR DEVICE
57.	–SHORT CIRCUIT OR GROUNDING DEVICE
58.	–RECTIFICATION FAILURE RELAY
59.	–OVERVOLTAGE RELAY
60.	–VOLTAGE OR CURRENT BALANCE RELAY
61.	–CURRENT BALANCE RELAY
62.	–TIME–DELAY STOPPING OR OPENING RELAY
63.	–FLUID PRESSURE, LEVEL OR FLOW RELAY
64.	–GROUND PROTECTIVE RELAY
65.	–GOVERNOR
66.	–NOTCHING OR JOGGING DEVICE
67.	–AC POWER DIRECTIONAL OR AC DIRECTIONAL OVERCURRENT RELAY
68.	–DC THERMAL RELAY
69.	–PERMISSIVE CONTROL DEVICE
70.	–ELECTRICALLY OPERATED RHEOSTAT
71.	–EMERGENCY DC LINE CIRCUIT BREAKER OR CONTACTOR
72.	–DC CIRCUIT BREAKER OR CONTACTOR
73.	–LOAD RESISTOR CIRCUIT BREAKER OR CONTACTOR
74.	–ALARM RELAY
75.	–POSITION CHANGING MECHANISM
76.	–DC OVERCURRENT RELAY
77.	–PULSE TRANSMITTER
78.	–PHASE–ANGLE MEASURING RELAY
79.	–AC RECLOSING RELAY
80.	–DC UNDERVOLTAGE RELAY
81.	–FREQUENCY DEVICE
82.	–DC RECLOSING RELAY
83.	–SEL. CONTROLLER, TRANS., CONTACTOR OR RELAY
84.	–OPERATION MECHANISM
85.	–CARRIER OR PILOT–WIRE RECEIVING RELAY
86.	–LOCKING–OUT RELAY OR DEVICE
87.	–DIFFERENTIAL CURRENT RELAY
88.	–AUXILLIARY MOTOR OR MOTOR GENERATOR
89.	–LINE SWITCH
90.	–REGULATING DEVICE
91.	–VOLTAGE DIRECTIONAL RELAY
92.	–VOLTAGE AND POWER DIRECTIONAL RELAY
93.	–FIELD–CHANGING CONTACTOR OR RELAY
94.	–TRIPPING OR TRIP–FREE RELAY OR CONTROLLER

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DRAWING NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV.	BY	DATE	REVISIONS	CHK.	DATE	S.L.	DATE
B	VA	16.07.24	ISSUED FOR CLIENT REVIEW	LC	16.07.24	KR	16.07.24
A	VA	15.07.24	ISSUED FOR REVIEW	LC			

PROFESSIONAL SEAL

DO NOT SCALE
IF IN DOUBT, ASK

CLIENT PROJECT MANAGER
CLIENT ENGINEERING MANAGER
CLIENT LEAD ENGINEER

CLIENT DRAWING NUMBER
00000

APPROVALS

APPROVAL	SIGNATURE	DATE	APPROVAL	SIGNATURE	DATE
PROJECT MANAGER	T. BUCKINGHAM		D.O. MANAGER		
PROJECT ENGINEER			SECTION LEADER		
PROJECT ENGINEER			DRAWN	V. ALAGIRISAMY	2024.07.12
DISCIPLINE ENGINEER			DRG. CHECKED		
DISCIPLINE ENGINEER			ENG. CHECKED	L. CULL	2024.07.12
DISCIPLINE ENGINEER					
DESIGN ENGINEER					

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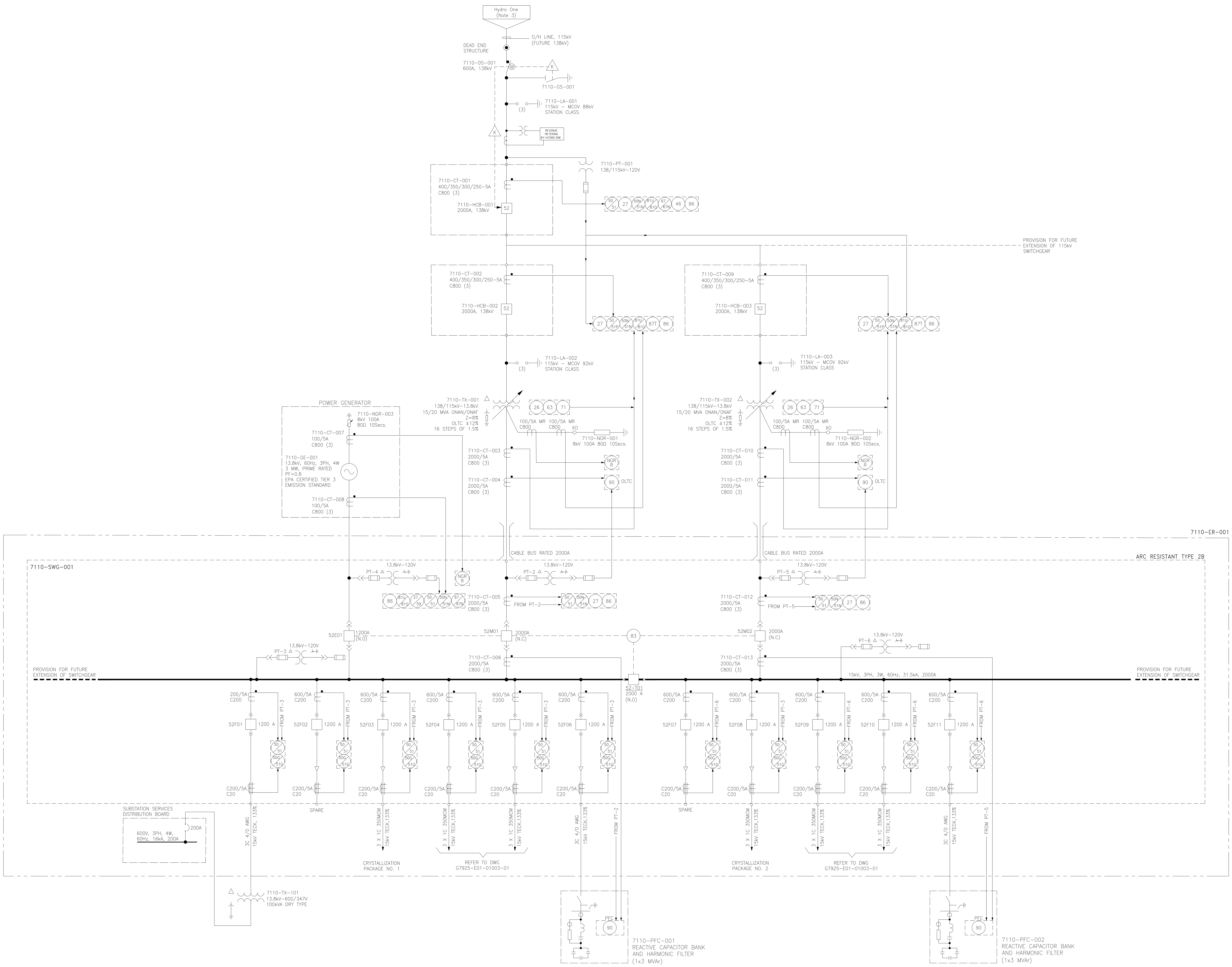
TITLE 07925 AVALON ADVANCED MATERIALS
LAKE SUPERIOR LITHIUM
ELECTRICAL
SYMBOLS AND LEGENDS
SINGLE LINE DIAGRAM

A0	PROJECT DWG No.	SHEET	REVISION	SCALE
	G7925 - E01 - 01001	1 OF 1	B	1:1 U.O.S.



NOTES:

1. TO MAXIMUM EXTENT POSSIBLE, ALL EQUIPMENT SHALL BE RATED FOR POSSIBLE UPGRADE FROM 115kV TO 138kV IN THE FUTURE INCLUDING NECESSARY LAYOUT CLEARANCES FOR INSULATOR AND OVERHEAD CONDUCTORS.
2. ALL CIRCUIT BREAKERS TO BE CONNECTED TO SCADA NETWORK BY IEC 61850 PROTOCOL.
3. PROVISION FOR FUTURE DUAL REDUNDANT OVERHEAD LINES FROM HYDRO ONE.

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REFERENCE DRAWINGS

DRAWING NO.	DESCRIPTION
G7925-E01-01003-01	MAIN SUBSTATION 115kV/138kV - 13.8kV - SINGLE LINE DIAGRAM
G7925-E01-01001-01	SYMBOLS AND LEGENDS - SINGLE LINE DIAGRAM

REVISIONS

REV.	BY	DATE	REVISIONS	CHK.	DATE	S.L.	DATE
B	VA	16.07.24	ISSUED FOR CLIENT REVIEW	LC	16.07.24	KR	16.07.24
A	VA	15.07.24	ISSUED FOR REVIEW	LC			

PROFESSIONAL SEAL

DO NOT SCALE
IF IN DOUBT, ASK

CLIENT PROJECT MANAGER		
CLIENT ENGINEERING MANAGER		
CLIENT LEAD ENGINEER		

CLIENT DRAWING NUMBER
00000

APPROVALS

APPROVAL	SIGNATURE	DATE	APPROVAL	SIGNATURE	DATE
PROJECT MANAGER	T. BUCKINGHAM		D.O. MANAGER		
PROJECT ENGINEER			SECTION LEADER		
PROJECT ENGINEER			DRAWN	V. ALAGIRISAMY	2024.07.12
DISCIPLINE ENGINEER			DRG. CHECKED		
DISCIPLINE ENGINEER			ENG. CHECKED	L. CULL	2024.07.12
DISCIPLINE ENGINEER					
DESIGN ENGINEER					

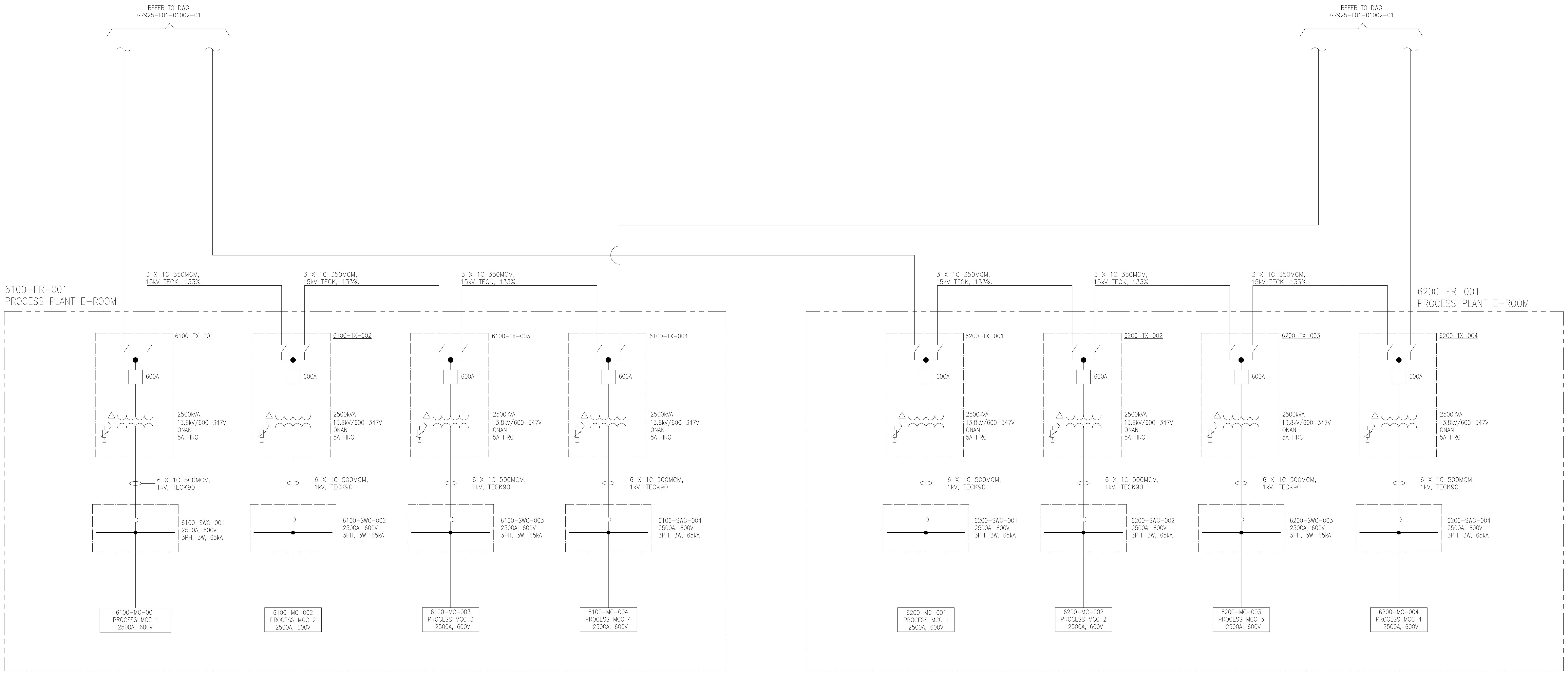
DRA Americas INC
20 Queen Street West / 29th Floor
Toronto / Ontario / M5H 3R3
Canada
draglobal.com

TITLE 07925 AVALON ADVANCED MATERIALS
LAKE SUPERIOR LITHIUM
ELECTRICAL
MAIN SUBSTATION 115kV/138kV – 13.8kV
SINGLE LINE DIAGRAM

A0	PROJECT DWG No.	SHEET	REVISION	SCALE
	G7925 - E01 - 01002	1 OF 1	B	1:1 U.O.S.

GENERAL NOTES:

1. E ROOM FEEDERS INSTALLED IN ABOVE GROUND CABLE TRAYS IN TRIPLEX FORMATION, WHERE REQUIRED.
2. CABLE INSULATION SHALL BE RATED FOR:
   (a) 8.7kV PHASE TO GROUND PEAK VOLTAGE.
   (b) 15kV PHASE TO PHASE PEAK VOLTAGE.
3. NUMBER OF MCC'S CONNECTED TO 600 VOLT SWITCHGEAR ALONG WITH SWITCHGEAR FEEDER BREAKERS TO MCC'S TO BE FINALIZED BASED ON PROCESS LOAD ASSIGNMENTS.



NOT TO BE USED FOR CONSTRUCTION

DRA FOR INFORMATION ONLY

DRAWING NO.	DESCRIPTION
G7925-E01-01002-01	MAIN SUBSTATION 115kV/138kV – 13.8kV – SINGLE LINE DIAGRAM
G7925-E01-01001	SYMBOLS AND LEGENDS – SINGLE LINE DIAGRAM

REFERENCE DRAWINGS

REV.	BY	DATE	REVISIONS	CHK.	DATE	S.L.	DATE
B	VA	16.07.24	ISSUED FOR CLIENT REVIEW	LC	16.07.24	KR	16.07.24
A	VA	15.07.24	ISSUED FOR REVIEW	LC			

PROFESSIONAL SEAL

DO NOT SCALE
IF IN DOUBT, ASK

CLIENT PROJECT MANAGER		
CLIENT ENGINEERING MANAGER		
CLIENT LEAD ENGINEER		

CLIENT DRAWING NUMBER
00000

APPROVALS

APPROVAL	SIGNATURE	DATE	APPROVAL	SIGNATURE	DATE
PROJECT MANAGER	T. BUCKINGHAM		D.O. MANAGER		
PROJECT ENGINEER			SECTION LEADER		
PROJECT ENGINEER			DRAWN	V. ALAGIRISAMY	2024.07.12
DISCIPLINE ENGINEER			DRG. CHECKED		
DISCIPLINE ENGINEER			ENG. CHECKED	L. CULL	2024.07.12
DISCIPLINE ENGINEER					
DESIGN ENGINEER					

DRA Americas INC
20 Queen Street West / 29th Floor
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TITLE 07925 AVALON ADVANCED MATERIALS
LAKE SUPERIOR LITHIUM
ELECTRICAL
MAIN SUBSTATION 115kV/138kV – 13.8kV
SINGLE LINE DIAGRAM

A0	PROJECT DWG No.	SHEET	REVISION	SCALE
	G7925 – E01 – 01003	1 OF 1	B	1:1 U.O.S.

Appendix F – Cash Flows

Date				7/1/2027	7/1/2028	7/1/2029	7/1/2030	7/1/2031	7/1/2032	7/1/2033	7/1/2034	7/1/2035	7/1/2036	7/1/2037
Period #				-2	-1	1	2	3	4	5	6	7	8	9
Period				FY-2	FY-1	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	FY9
Calendar Year				2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
PRE-TAX CASH FLOW			*(Tot. / Avg.)*											
Net Revenue	*($'000s)*		**$31,853,554**	-	$46,325	$582,429	$1,039,282	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141
Less: Total Operating Costs	*($'000s)*		**($11,801,422)**	-	($52,843)	($268,757)	($413,676)	($397,710)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)
Operating Earnings	*($'000s)*		**$20,052,132**	-	($6,518)	$313,671	$625,606	$661,431	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387
Capital Expenditures														
Development Capital	*($'000s)*		**($1,213,253)**	($181,988)	($485,301)	($545,964)	-	-	-	-	-	-	-	-
Sustaining Capital	*($'000s)*		**($62,000)**	-	-	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)
Closure Capital	*($'000s)*		**($40,000)**	-	-	-	-	-	-	-	-	-	-	-
Clean Technology Manufacturing ITC	*($'000s)*		**$321,697**	-	$48,254	$128,679	$144,763	-	-	-	-	-	-	-
Changes in Working Capital	*($'000s)*		**$0**	-	$2,700	($17,436)	($19,683)	($3,601)	($874)	($107)	-	-	$107	($107)
Pre-Tax Cash Flow	*($'000s)*		**$19,058,575**	**($181,988)**	**($440,865)**	**($123,050)**	**$748,687**	**$655,830**	**$666,513**	**$667,281**	**$667,387**	**$667,387**	**$667,494**	**$667,281**
Adj. Cumulative Pre-Tax Cash Flow	*($'000s)*			*($181,988)*	*($622,853)*	*($745,904)*	*$2,783*	*$658,613*	*$1,325,126*	*$1,992,407*	*$2,659,794*	*$3,327,181*	*$3,994,675*	*$4,661,956*
Payback Period	*(years)*		**2.00**	*0.0*	*0.0*	*0.0*	*728.6*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Mid-Year Adjustment		Y												
Discounting Index		-2		*0.5*	*1.5*	*2.5*	*3.5*	*4.5*	*5.5*	*6.5*	*7.5*	*8.5*	*9.5*	*10.5*
Discount Factor	*(x)*	8.0		*0.962*	*0.891*	*0.825*	*0.764*	*0.707*	*0.655*	*0.606*	*0.561*	*0.520*	*0.481*	*0.446*
Discounted Pre-Tax Cash Flow	*($'000s)*		**$5,558,959**	**($175,118)**	**($392,799)**	**($101,514)**	**$571,896**	**$463,857**	**$436,494**	**$404,626**	**$374,714**	**$346,957**	**$321,308**	**$297,412**
Pre-Tax IRR	*(%)*		**55.5%**											
Pre-Tax XIRR	*(%)*		**55.5%**											
Payback Period	*(years)*		**2.00**											
Adj. Cumulative Pre-Tax Discounted Cash Flo	*($'000s)*			*($175,118)*	*($567,917)*	*($669,430)*	*($97,534)*	*$366,323*	*$802,817*	*$1,207,443*	*$1,582,157*	*$1,929,114*	*$2,250,422*	*$2,547,834*
Discounted Payback Period	*(years)*		**2.21**	*0.0*	*0.0*	*0.0*	*0.0*	*806.7*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
AFTER-TAX CASH FLOW			*(Tot. / Avg.)*											
Pre-Tax Cash Flow	*($'000s)*		**$19,058,575**	($181,988)	($440,865)	($123,050)	$748,687	$655,830	$666,513	$667,281	$667,387	$667,387	$667,494	$667,281
Less: Income Tax Paid	*($'000s)*		**($4,775,991)**	-	-	-	($100,923)	($142,283)	($149,916)	($154,149)	($157,323)	($159,704)	($161,490)	($162,829)
After-Tax Cash Flow	*($'000s)*		**$14,282,584**	**($181,988)**	**($440,865)**	**($123,050)**	**$647,764**	**$513,547**	**$516,597**	**$513,132**	**$510,064**	**$507,683**	**$506,004**	**$504,452**
Adj. Cumulative After-Tax Cash Flow	*($'000s)*			*($181,988)*	*($622,853)*	*($745,904)*	*($98,140)*	*$415,407*	*$932,003*	*$1,445,135*	*$1,955,199*	*$2,462,882*	*$2,968,886*	*$3,473,338*
Payback Period	*(years)*		**2.19**	*0.0*	*0.0*	*0.0*	*0.0*	*799.8*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Discount Factor	*(x)*			*0.962*	*0.891*	*0.825*	*0.764*	*0.707*	*0.655*	*0.606*	*0.561*	*0.520*	*0.481*	*0.446*
Discounted After-Tax Cash Flow	*($'000s)*		**$4,119,243**	**($175,118)**	**($392,799)**	**($101,514)**	**$494,804**	**$363,223**	**$338,315**	**$311,153**	**$286,382**	**$263,931**	**$243,572**	**$224,838**
After-Tax IRR	*(%)*		**47.5%**											
Pre-Tax XIRR	*(%)*		**47.5%**											
Payback Period	*(years)*		**2.19**											
Adj. Cumulative Pre-Tax Discounted Cash Flo	*($'000s)*			*($175,118)*	*($567,917)*	*($669,430)*	*($174,626)*	*$188,597*	*$526,911*	*$838,065*	*$1,124,447*	*$1,388,378*	*$1,631,951*	*$1,856,789*
Discounted Payback Period	*(years)*		**2.48**	*0.0*	*0.0*	*0.0*	*0.0*	*905.5*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Date				7/1/2038	7/1/2039	7/1/2040	7/1/2041	7/1/2042	7/1/2043	7/1/2044	7/1/2045	7/1/2046	7/1/2047	7/1/2048	7/1/2049
Period #				10	11	12	13	14	15	16	17	18	19	20	21
Period				FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21
Calendar Year				2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
PRE-TAX CASH FLOW			*(Tot. / Avg.)*												
Net Revenue	*($'000s)*		**$31,853,554**	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141
Less: Total Operating Costs	*($'000s)*		**($11,801,422)**	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)
Operating Earnings	*($'000s)*		**$20,052,132**	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387
Capital Expenditures															
Development Capital	*($'000s)*		**($1,213,253)**	-	-	-	-	-	-	-	-	-	-	-	-
Sustaining Capital	*($'000s)*		**($62,000)**	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)
Closure Capital	*($'000s)*		**($40,000)**	-	-	-	-	-	-	-	-	-	-	-	-
Clean Technology Manufacturing ITC	*($'000s)*		**$321,697**	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Working Capital	*($'000s)*		**$0**	-	-	$107	($107)	-	-	$107	($107)	-	-	$107	($107)
Pre-Tax Cash Flow	*($'000s)*		**$19,058,575**	**$667,387**	**$667,387**	**$667,494**	**$667,281**	**$667,387**	**$667,387**	**$667,494**	**$667,281**	**$667,387**	**$667,387**	**$667,494**	**$667,281**
Adj. Cumulative Pre-Tax Cash Flow	*($'000s)*			*$5,329,343*	*$5,996,730*	*$6,664,224*	*$7,331,505*	*$7,998,892*	*$8,666,279*	*$9,333,773*	*$10,001,054*	*$10,668,441*	*$11,335,828*	*$12,003,322*	*$12,670,602*
Payback Period	*(years)*		**2.00**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Mid-Year Adjustment		Y													
Discounting Index		-2		*11.5*	*12.5*	*13.5*	*14.5*	*15.5*	*16.5*	*17.5*	*18.5*	*19.5*	*20.5*	*21.5*	*22.5*
Discount Factor	*(x)*	8.0		*0.413*	*0.382*	*0.354*	*0.328*	*0.303*	*0.281*	*0.260*	*0.241*	*0.223*	*0.206*	*0.191*	*0.177*
Discounted Pre-Tax Cash Flow	*($'000s)*		**$5,558,959**	**$275,426**	**$255,024**	**$236,171**	**$218,607**	**$202,446**	**$187,450**	**$173,593**	**$160,683**	**$148,804**	**$137,781**	**$127,596**	**$118,107**
Pre-Tax IRR	*(%)*		**55.5%**												
Pre-Tax XIRR	*(%)*		**55.5%**												
Payback Period	*(years)*		**2.00**												
Adj. Cumulative Pre-Tax Discounted Cash Flo	*($'000s)*			*$2,823,260*	*$3,078,284*	*$3,314,455*	*$3,533,062*	*$3,735,508*	*$3,922,959*	*$4,096,551*	*$4,257,234*	*$4,406,038*	*$4,543,820*	*$4,671,415*	*$4,789,522*
Discounted Payback Period	*(years)*		**2.21**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
AFTER-TAX CASH FLOW			*(Tot. / Avg.)*												
Pre-Tax Cash Flow	*($'000s)*		**$19,058,575**	$667,387	$667,387	$667,494	$667,281	$667,387	$667,387	$667,494	$667,281	$667,387	$667,387	$667,494	$667,281
Less: Income Tax Paid	*($'000s)*		**($4,775,991)**	($163,834)	($164,587)	($165,152)	($165,576)	($165,893)	($166,132)	($166,311)	($166,445)	($166,545)	($166,621)	($166,677)	($166,720)
After-Tax Cash Flow	*($'000s)*		**$14,282,584**	**$503,554**	**$502,800**	**$502,342**	**$501,705**	**$501,494**	**$501,255**	**$501,183**	**$500,836**	**$500,842**	**$500,767**	**$500,817**	**$500,561**
Adj. Cumulative After-Tax Cash Flow	*($'000s)*			*$3,976,891*	*$4,479,692*	*$4,982,034*	*$5,483,739*	*$5,985,233*	*$6,486,488*	*$6,987,671*	*$7,488,507*	*$7,989,350*	*$8,490,116*	*$8,990,933*	*$9,491,494*
Payback Period	*(years)*		**2.19**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Discount Factor	*(x)*			*0.413*	*0.382*	*0.354*	*0.328*	*0.303*	*0.281*	*0.260*	*0.241*	*0.223*	*0.206*	*0.191*	*0.177*
Discounted After-Tax Cash Flow	*($'000s)*		**$4,119,243**	**$207,813**	**$192,132**	**$177,737**	**$164,363**	**$152,124**	**$140,788**	**$130,341**	**$120,602**	**$111,670**	**$103,383**	**$95,734**	**$88,598**
After-Tax IRR	*(%)*		**47.5%**												
Pre-Tax XIRR	*(%)*		**47.5%**												
Payback Period	*(years)*		**2.19**												
Adj. Cumulative Pre-Tax Discounted Cash Flo	*($'000s)*			*$2,064,602*	*$2,256,734*	*$2,434,471*	*$2,598,834*	*$2,750,958*	*$2,891,746*	*$3,022,087*	*$3,142,690*	*$3,254,360*	*$3,357,743*	*$3,453,477*	*$3,542,075*
Discounted Payback Period	*(years)*		**2.48**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Date				7/1/2050	7/1/2051	7/1/2052	7/1/2053	7/1/2054	7/1/2055	7/1/2056	7/1/2057	7/1/2058	7/1/2059	7/1/2060	7/1/2061
Period #				22	23	24	25	26	27	28	29	30	31	32	33
Period				FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33
Calendar Year				2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061
PRE-TAX CASH FLOW			*(Tot. / Avg.)*												
Net Revenue	*($'000s)*		**$31,853,554**	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$1,059,141	$529,571	-	-
Less: Total Operating Costs	*($'000s)*		**($11,801,422)**	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($389,754)	($145,084)	-	-
Operating Earnings	*($'000s)*		**$20,052,132**	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$669,387	$384,487	-	-
Capital Expenditures															
Development Capital	*($'000s)*		**($1,213,253)**	-	-	-	-	-	-	-	-	-	-	-	-
Sustaining Capital	*($'000s)*		**($62,000)**	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	($2,000)	-	-
Closure Capital	*($'000s)*		**($40,000)**	-	-	-	-	-	-	-	-	-	-	($40,000)	-
Clean Technology Manufacturing ITC	*($'000s)*		**$321,697**	-	-	-	-	-	-	-	-	-	-	-	-
Changes in Working Capital	*($'000s)*		**$0**	-	-	$107	($107)	-	-	$107	($107)	-	$39,001	-	-
Pre-Tax Cash Flow	*($'000s)*		**$19,058,575**	**$667,387**	**$667,387**	**$667,494**	**$667,281**	**$667,387**	**$667,387**	**$667,494**	**$667,281**	**$667,387**	**$421,488**	**($40,000)**	**-**
Adj. Cumulative Pre-Tax Cash Flow	*($'000s)*			*$13,337,990*	*$14,005,377*	*$14,672,871*	*$15,340,151*	*$16,007,539*	*$16,674,926*	*$17,342,420*	*$18,009,700*	*$18,677,087*	*$19,098,575*	*$19,058,575*	*$19,058,575*
Payback Period	*(years)*		**2.00**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Mid-Year Adjustment		Y													
Discounting Index		-2		*23.5*	*24.5*	*25.5*	*26.5*	*27.5*	*28.5*	*29.5*	*30.5*	*31.5*	*32.5*	*33.5*	*34.5*
Discount Factor	*(x)*	8.0		*0.164*	*0.152*	*0.141*	*0.130*	*0.120*	*0.112*	*0.103*	*0.096*	*0.089*	*0.082*	*0.076*	*0.070*
Discounted Pre-Tax Cash Flow	*($'000s)*		**$5,558,959**	**$109,375**	**$101,274**	**$93,787**	**$86,812**	**$80,394**	**$74,439**	**$68,936**	**$63,809**	**$59,092**	**$34,555**	**($3,036)**	**-**
Pre-Tax IRR	*(%)*		**55.5%**												
Pre-Tax XIRR	*(%)*		**55.5%**												
Payback Period	*(years)*		**2.00**												
Adj. Cumulative Pre-Tax Discounted Cash Flo	*($'000s)*			*$4,898,897*	*$5,000,171*	*$5,093,958*	*$5,180,769*	*$5,261,164*	*$5,335,603*	*$5,404,539*	*$5,468,348*	*$5,527,440*	*$5,561,995*	*$5,558,959*	*$5,558,959*
Discounted Payback Period	*(years)*		**2.21**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
AFTER-TAX CASH FLOW			*(Tot. / Avg.)*												
Pre-Tax Cash Flow	*($'000s)*		**$19,058,575**	$667,387	$667,387	$667,494	$667,281	$667,387	$667,387	$667,494	$667,281	$667,387	$421,488	($40,000)	-
Less: Income Tax Paid	*($'000s)*		**($4,775,991)**	($166,751)	($166,775)	($166,793)	($166,807)	($166,817)	($166,824)	($166,830)	($166,834)	($166,837)	($95,615)	-	-
After-Tax Cash Flow	*($'000s)*		**$14,282,584**	**$500,636**	**$500,612**	**$500,701**	**$500,474**	**$500,571**	**$500,563**	**$500,664**	**$500,447**	**$500,550**	**$325,873**	**($40,000)**	**-**
Adj. Cumulative After-Tax Cash Flow	*($'000s)*			*$9,992,130*	*$10,492,742*	*$10,993,443*	*$11,493,917*	*$11,994,487*	*$12,495,050*	*$12,995,714*	*$13,496,161*	*$13,996,711*	*$14,322,584*	*$14,282,584*	*$14,282,584*
Payback Period	*(years)*		**2.19**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Discount Factor	*(x)*			*0.164*	*0.152*	*0.141*	*0.130*	*0.120*	*0.112*	*0.103*	*0.096*	*0.089*	*0.082*	*0.076*	*0.070*
Discounted After-Tax Cash Flow	*($'000s)*		**$4,119,243**	**$82,047**	**$75,966**	**$70,351**	**$65,111**	**$60,299**	**$55,832**	**$51,707**	**$47,856**	**$44,320**	**$26,716**	**($3,036)**	**-**
After-Tax IRR	*(%)*		**47.5%**												
Pre-Tax XIRR	*(%)*		**47.5%**												
Payback Period	*(years)*		**2.19**												
Adj. Cumulative Pre-Tax Discounted Cash Flo	*($'000s)*			*$3,624,122*	*$3,700,088*	*$3,770,439*	*$3,835,550*	*$3,895,849*	*$3,951,681*	*$4,003,388*	*$4,051,243*	*$4,095,563*	*$4,122,280*	*$4,119,243*	*$4,119,243*
Discounted Payback Period	*(years)*		**2.48**	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*